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Canada

SMALL POWER PRODUCTION IN REMOTE COMMUNITIES:
A Shared Opportunity

SMALL POWER PRODUCTION FOR

REMOTE COMMUNITIES:

A SHARED OPPORTUNITY

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PREFACE

Canada's remote communities are unique. Differences in lifestyle, social and economic conditions as well as geography and climate set these communities apart from the rest of Canada. These remote communities also have different energy needs and energy options. Many must rely on costly diesel generated electricity. Fortunately, there are now opportunities to improve the energy situation through energy conservation and alternative energy technologies. One of these options is to generate electricity from renewable energy sources, thereby saving valuable diesel fuel without compromising electrical service.

This manual has been prepared by the Scenario, IBI Group for remote communities, with funding from the Remote Community Demonstration Program of Energy, Mines and Resources Canada. It is hoped that the information will assist those willing to employ practical energy alternatives which will result in energy and cost savings while providing better electrical service for consumers.

The Remote Community Demonstration Program was established by EMR Canada to help remote communities and agencies identify more appropriate energy alternatives and energy conservation opportunities.

This manual was produced in consultation with members of small power producer associations and representatives of the Canadian Electrical Association R & D Programs.

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SUMMARY

1.0 OVERVIEW

- This manual focusses on the sale of electric power from privately installed small-hydro and wind power systems to utilities in remote communities.
- Its purpose is to facilitate the development of power sale and purchase agreements between small power producers and utilities.
- With over 300 remote communities across Canada, the potential for this type of system is great.
- These projects, however, are extremely complex and many factors have to be taken into account to ensure the success of a project. This manual has been prepared to assist those interested in establishing hydro or wind power systems.

Benefits From Small Power Installations

- Benefits from remote power installations may accrue to utilities, communities, and small power producers.
- An important benefit is the potential reduction of the cost of power generation to the utility. This may help the utility offset deficits involved in the subsidization of power to the communities.
- Another benefit to the utility may be the deferral of plant expansion in the communities.
- The utility, however, is also motivated by its responsibilities to the community and its own employees and is interested in minimizing any possible negative impact of the new installation on its own equipment.
- Reduction in the use of diesel fuel will also result in a reduction in environmental problems associated with the transportation, containment and combustion of diesel fuel.
- Another possible benefit is a reduction in the cost of electricity to consumers in remote communities.
- Provision of jobs in the construction, installation, operation, and maintenance of the systems is also a benefit.
- Although the sale of power from small power producers to utilities in remote communities is a relatively new business, the private sector is looking at these installations as a sound business investment.
- Currently, there is a wide variation in the price utilities will pay for independent power. There are no standardized techniques for valuing the power, and the methods used vary from utility to utility.
- Early contact between the parties is important. The key actors get to know each other, and there is the basis for the development of a good relationship. Knowledge and experience can also be shared.

2.0 PROJECT MANAGEMENT CONSIDERATIONS

- Good project management is critical to the success of remote power projects. The interests and concerns of all parties must be considered if the project is to be successful.
- There are a variety of regulations, by-laws, codes and policies that have to be adhered to in the course of completing a project. Government approvals and utility policies must also be considered.
- Utilities are concerned with the credibility of small power producers. Consequently, the small power producer should identify competent staff to manage the project and should establish a well coordinated and organized corporation, and a sound project plan.
- Project financing is a major consideration for the small power producer. The small power producer may have to approach banking institutions or the financial community with a well developed and detailed business plan in order to obtain funding for the project. Cost sharing arrangements with the utility, the community or with various levels of government should be considered.
- It may also be worthwhile for the utility to explore funding the small power producer itself. In this way the utility could gain back revenue spent on purchasing power from the interest payments on capital loaned to the small power producer. There is the possibility, however, that this type of funding arrangement could lead to a conflict of interest.
- Responsibilities should be carefully divided between the small power producer and the utility. Usually, the small power producer is responsible for delivering reliable high quality power to the utility and must convince the utility that a project is viable.
- Choice of technology is important to the success of a project. Utilities need to be convinced of the reliability of the chosen technology and may not approve a project if the reliability is unproven.
- Limitations to remote power installations include:
  - the availability of the renewable resource;
  - sizing of the small power installation;
  - impact on the existing diesel system
  - construction logistics;
  - transportation costs;
  - ongoing operation and maintenance costs.
- It is the responsibility of the small power producer to obtain approvals for the project from the utility, various government agencies, and the community.
- The small power producer must also supply guarantees before the utility will feel comfortable enough to sign a purchase of power agreement.

These guarantees should cover the project's timing, the testing of equipment, the manufacturers' warranties and all service arrangements.

3.0 FINANCIAL CONSIDERATIONS

- Both the small power producer and the utility have the option to finance installations, although it is normally up to the small power producer to obtain the funds.
- Payback analyses must be conducted by the small power producer and the utility to determine the financial feasibility of the project. The two parties may use different methods of analysis. The small power producer may use the discounted cash flow method whereas the utility may have its own analytical methods to evaluate a project.
- The small power producer may sign one of three basic types of facility development agreements: a turnkey agreement to install for the utility, a short-term purchase of power agreement, or a long-term purchase of power agreement.
- The price paid for the power is an area of concern to both the small power producer and the utility. A debate is currently taking place concerning the methods used to value the power.

4.0 SOCIAL AND ECONOMIC CONSIDERATIONS

- Job creation, reduced power costs, and increased economic development are potential economic and social benefits flowing from remote, renewable power installations.
- Jobs may be created in the local community, particularly for short-term opportunities during the construction and installation phases of the project.
- If a small power producer sells power directly to a community, costs to the community could be reduced, particularly in the institutional and commercial sectors. If a small power producer sells power to a utility, it is unlikely that the community would benefit from a rate reduction.
- If the cost of generation is reduced, the community could benefit because more capital is kept in the community. This could contribute to an improvement in the quality of life.

5.0 TECHNICAL CONSIDERATIONS

- The development of a sound concept plan and feasibility study is essential to the success of a project. This plan or study is the responsibility of the small power producer. It should address:
  - existing energy costs;
  - scale of investment to be made;
  - technology to be employed;
  - existing plant characteristics;
  - existing policy and power specifications of the utility;

  - anticipated revenues;
  - availability of resources, land, equipment, labour and materials.

- Once a plan has been developed, and an installation has been determined as viable, the small power producer must undertake a detailed feasibility study. This usually requires professional assistance.

- A proposal, including detailed plans, must then be submitted to the utility. A recent proposal to one western utility focussed on over forty areas of concern.

- Proper site selection is critical to a successful project. Proximity to the community, overall capacity of the installation, and access to the site are important factors to consider.

- Safety is a major concern to utilities, small power producers and communities. The onus is on the small power producer to prove to the utility and to the community the complete safety of the installation. Adequate protection for community members, construction workers, and utility staff must be maintained at all times.

- Power quality and interconnection with the community distribution system is another area of concern. Utilities prefer to specify utility grade equipment to accomplish these ends, whereas small power producers may wish to put forward alternatives.

- The operation and maintenance of remote power systems must be carefully planned for, particularly because of the remoteness of the sites, and the time and cost incurred in maintenance. Training of operators and adequate provision of replacement parts both contribute to keeping operation and maintenance costs down.

- Utilities are concerned with the impact of small power producers' installations on their own equipment. They are also concerned about the cost of any modifications they may have to make to their own system, such as the cost of upgrading the community distribution system if overall system capacity is increased, or if modification to existing control systems is necessary.

- Although the environmental impact of small, remote power systems is normally low, the small power producer may have to prove this to the utility and governmental regulating agencies. This may involve developing an environmental impact assessment report or filing for an exemption under federal or provincial regulations.

- Utilities are concerned with the overall design, system selection, and performance of equipment installed by small power producers. In general, they have expressed concern with the civil and mechanical designs being put forward by small power producers. It is the responsibility of the small power producer to convince the utility of the appropriateness and reliability of the system being proposed.

- The installation of remote power systems is a complex task involving the following factors:
  - the logistics of transportation;
  - the availability of equipment on site;
  - the availability of materials on site;
  - the availability and skills of local labor;
  - the construction techniques which are used.
- In each case, the factors taken into account may differ from those in the southern environment. Careful planning will anticipate all potential problems resulting from the isolated nature of the site.

6.0 LEGAL CONSIDERATIONS

- From the point-of-view of the utility, the small power producer must be a distinct legal entity (corporation) in order to undertake the project.
- The small power producer (corporation) must engage legal and technical assistance, carry adequate insurance and provide all necessary public protection.
- The following topics should be included in discussions between the small power producer and the utility:
  - responsibilities of each party;
  - rights of each party;
  - project time frame, approvals, construction, installation, and start up; duration of contract, options for renewal;
  - power quality and interconnection requirements;
  - calculation of rates;
  - conditions of payment;
  - responsibility for operation and maintenance;
  - metering, monitoring of power.
- Legal concerns may arise in the following areas:
  - method of calculating value of power;
  - conditions for payment;
  - capacity factor;
  - performance guarantees;
  - time frame of agreement and provisions for renewal.
- The small power producer must ensure that:
  - all pertinent government approvals are obtained;
  - indemnification is obtained;
  - the system is properly operated and maintained;
  - manufacturer's warranties are provided.

Summary

- Normally, the utility is responsible for inspection and approval of the installation.
- The small power producer must acquire the right-of-way for any transmission line that might be required. Any other legal impediments to the installation must also be identified and action taken to resolve the problem.
- The small power producer and the utility must apportion the legal responsibility in the event of power interruptions from the small power producer's system.

SOMMAIRE

1.0 APERÇU

- Ce manuel porte principalement sur la vente d'énergie électrique aux services publics, par de petits producteurs d'électricité privés, dans les collectivités éloignées.
- Il a pour objectif de faciliter la réalisation de contrats de vente et d'achat d'énergie entre des petits producteurs et des services publics ainsi que les relations entre les deux parties.
- Avec plus de 300 collectivités éloignées au Canada, ce type de réseau offre d'immenses possibilités.
- Ces projets sont cependant très complexes et de nombreux facteurs doivent être pris en considération pour en garantir le succès. Ce manuel a été rédigé dans cette perspective.

Avantages des petits réseaux d'énergie

- Les avantages des réseaux d'énergie dans les collectivités éloignées peuvent profiter aux services publics, aux collectivités et aux petits producteurs.
- La réduction possible du coût de production de l'électricité au service public représente un avantage important. Cette réduction peut l'aider à compenser les déficits dus à la subvention d'électricité aux collectivités.
- Le report de l'expansion de centrales diesels dans les collectivités peut également représenter un autre avantage pour le service public.
- Le service public est également motivé par sa responsabilité à l'égard de la collectivité et de ses employés et il souhaite minimiser l'effet négatif de la nouvelle installation sur son propre équipement.
- La diminution de l'emploi de carburant diesel réduira également les problèmes écologiques associés au transport, à l'entreposage et à la combustion de ce carburant.
- La réduction du coût de l'électricité vendue aux abonnés des collectivités éloignées est également un autre avantage possible.
- La création d'emplois reliés à la construction, à l'installation, à l'exploitation et à l'entretien des réseaux représente également un avantage.
- La vente d'énergie par de petits producteurs à des services publics de collectivités éloignées est une entreprise relativement nouvelle, mais le secteur privé considère ces installations comme un investissement judicieux.
- Il y a actuellement d'importantes variations dans le prix que les services publics paient pour obtenir une énergie indépendante. Il n'existe pas de technique normalisée pour évaluer l'énergie électrique et les méthodes utilisées varient d'un service public à l'autre.

- Lorsque les parties se mettent en rapport assez tôt, les principaux intéressés apprennent à se connaître, ce qui permet d'établir de bonnes relations. Ces rencontres entre les deux parties permettent également de partager connaissances et expérience.

2.0 CONSIDÉRATIONS RELATIVES À LA GESTION DE PROJET

- Une bonne gestion est indispensable au succès des projets dans les régions éloignées. Les intérêts et les préoccupations de toutes les parties doivent être pris en considération pour la bonne gestion d'un projet.

- Pendant l'exécution d'un projet, il est nécessaire de se soumettre à une réglementation, et à un bon nombre de règlements, codes et politiques. Les approbations gouvernementales et les politiques du service public doivent également être prises en considération.

- Les services publics s'inquiètent de la crédibilité des petits producteurs d'énergie et ceux-ci doivent, par conséquent, présenter un personnel formé, ainsi qu'une entreprise et un plan ayant fait l'objet d'une saine organisation et d'une coordination appropriée pour la gestion du projet.

- Le financement du projet constitue une préoccupation importante pour le petit producteur d'énergie. Il se peut que ce dernier doive s'adresser aux institutions bancaires ou à la communauté financière avec un plan élaboré et détaillé afin d'obtenir le financement du projet. Le partage des coûts par divers niveaux de gouvernement, les services publics ou les collectivités doit, par conséquent, être envisagé.

- Les services publics devraient peut-être penser à financer eux-mêmes les petits producteurs. De cette façon, les services publics pourraient récupérer les sommes dépensées pour l'achat d'électricité avec les paiements d'intérêt sur le capital prêté au petit producteur. Cependant, ce type de financement peut donner lieu à des conflits d'intérêt.

- Les responsabilités doivent être soigneusement réparties entre le petit producteur et le service public. D'une manière générale, le petit producteur doit fournir de l'électricité fiable et de grande qualité, et il doit convaincre le service public qu'un projet est viable.

- Le choix de la technologie est important pour assurer le succès d'un projet. Les services publics doivent être convaincus de la fiabilité de la technologie choisie et peuvent ne pas approuver un projet si cette fiabilité n'a pas été démontrée.

- Les installations électriques dans les collectivités éloignées comportent des limites. Ces limites ont trait à:

  - La disponibilité de ressources renouvelables;
  - L'importance du petit réseau d'électricité;
  - L'effet sur le système diesel existant;
  - La logistique de la construction;

- Les coûts de transport;
- Les frais d'exploitation et d'entretien.

- Il revient au petit producteur d'obtenir les approbations pour le projet du service public, de divers organismes gouvernementaux et de la collectivité.

- Il doit également fournir des garanties. Avant de se sentir à l'aise pour signer un accord d'achat d'électricité avec un petit producteur, un service public doit recevoir le calendrier du projet, les résultats des tests de l'équipement, ainsi que les garanties des fabricants et les dispositions prises pour le service après-vente.

3.0 CONSIDÉRATIONS FINANCIÈRES

- Le petit producteur et le service public peuvent financer les installations, mais c'est normalement au petit producteur qu'il revient d'obtenir les fonds.

- Des analyses financières doivent être effectuées par le petit producteur et le service public pour déterminer la rentabilité du projet. Les deux parties peuvent utiliser des méthodes différentes d'analyse. Le petit producteur peut utiliser la méthode des flux actualisés alors que le service public a généralement ses propres méthodes analytiques d'évaluation de l'aspect financier d'un projet.

- Le petit producteur peut signer trois types de contrat d'aménagement d'installation : un contrat « clés en main » d'installation pour les services publics, un contrat d'achat d'énergie à court terme et un contrat d'achat d'électricité à long terme.

- Le prix de l'énergie est un sujet d'inquiétude pour le petit producteur et pour le service public. Un débat a actuellement lieu au sujet des méthodes utilisées en matière d'évaluation de l'électricité.

4.0 CONSIDÉRATIONS SOCIALES ET ÉCONOMIQUES

- La création d'emplois, des coûts d'électricité réduits et une expansion économique accrue représentent des avantages économiques et sociaux qui pourraient résulter de l'aménagement d'installations d'énergie électrique renouvelable dans les collectivités éloignées.

- La collectivité peut bénéficier de la création d'emplois. Ces emplois représentent des débouchés à court terme pendant les phases de construction et d'installation du projet.

- Si un petit producteur vend directement de l'énergie à une collectivité, les coûts à défrayer par cette dernière seront réduits, particulièrement pour les secteurs des institutions et du commerce. Si un petit producteur vend de l'électricité à un service public, il est improbable que la collectivité puisse bénéficier d'une réduction de tarif.

- La réduction du coût de production laisserait à la collectivité l'usage de capitaux plus importants, et contribuerait à l'amélioration de la qualité de la vie.

5.0 CONSIDÉRATIONS TECHNIQUES

- La réalisation d'un bon plan de conception et d'une étude de faisabilité est essentielle au succès d'un projet. Le petit producteur est responsable de ce plan ou de cette étude qui doivent traiter des éléments suivants :
  - Coûts de l'énergie existante;
  - Importance de l'investissement;
  - Technologie à utiliser;
  - Caractéristiques de l'usine existante;
  - Politiques actuelles du service public et spécifications relatives à la puissance;
  - Revenus prévus;
  - Disponibilité des ressources, des terrains, de l'équipement, de la main-d'œuvre et du matériel.
- Lorsque ce plan est réalisé et qu'une installation a été déterminée viable, une étude détaillée de faisabilité doit être entreprise par le petit producteur aidé de professionnels.
- Ensuite, des plans détaillés et une proposition doivent être remis au service public. Une proposition récente présentée à un service public de l'Ouest traitait de plus de 40 domaines de préoccupation.
- Le choix d'un bon emplacement est essentiel au succès d'un projet. La proximité de la collectivité, la capacité totale de l'installation et l'accès à l'emplacement, constituent d'importants facteurs à prendre en considération.
- La sécurité est une préoccupation importante pour les services publics, les petits producteurs et les collectivités. Le petit producteur doit démontrer aux services publics et à la collectivité la sécurité absolue de l'installation. Une protection suffisante doit être assurée en tout temps aux membres de la collectivité, aux travailleurs du secteur de la construction et au personnel du service public.
- La qualité de l'énergie électrique et l'interconnexion avec le réseau de distribution de la collectivité constituent un autre domaine d'inquiétude. Les services publics préfèrent spécifier un équipement qui satisfont à leurs normes, alors que les petits producteurs d'électricité souhaitent parfois proposer d'autres choix.
- L'exploitation et l'entretien des réseaux d'énergie électrique dans les collectivités éloignées doivent être soigneusement planifiés, en particulier à cause de l'éloignement des emplacements, de même que du temps et des coûts d'entretien. La formation des opérateurs et un approvisionnement suffisant en pièces de rechange contribuent à maintenir à un niveau raisonnable les coûts d'exploitation et d'entretien.
- Les services publics s'inquiètent de l'effet des installations des petits producteurs sur leur propre équipement. Ils sont également préoccupés par le coût des modifications devant être apportées à leurs systèmes, comme les

frais de modernisation du réseau de distribution de la collectivité en cas d'augmentation de la capacité totale du système et si une modernisation est nécessaire ou si des modifications des systèmes de commande existants doivent avoir lieu.

- Les répercussions écologiques des réseaux d'énergie électrique dans les collectivités éloignées sont normalement faibles. Le petit producteur peut cependant devoir le démontrer aux services publics et aux organismes gouvernementaux investis d'un pouvoir de réglementation. Pour cela, il peut être nécessaire de rédiger un rapport d'évaluation des incidences environnementales ou de déposer une demande d'exemption dans le cadre de la réglementation fédérale ou provinciale.

- Les services publics se préoccupent de la conception, du choix du système et du rendement de l'équipement installé par de petits producteurs. Ils ont également exprimé leur inquiétude au sujet des projets civils et mécaniques présentés par de petits producteurs d'électricité. Il appartient à ces derniers de convaincre le service public du bien-fondé et de la fiabilité du système proposé.

- L'installation de réseaux d'énergie électrique dans les collectivités éloignées est une tâche complexe qui comporte :

- la logistique du transport;

- la disponibilité de l'équipement sur place;

- la disponibilité du matériel sur le chantier;

- l'existence et la compétence de la main-d'œuvre locale;

- le recours à des techniques de construction.

- Dans chaque cas, les facteurs pris en considération peuvent différer de ceux qui le seraient dans un contexte plus méridional. Afin de prévoir tous les problèmes qui pourraient être dus à l'éloignement des chantiers, une planification très élaborée doit être entreprise.

6.0 CONSIDÉRATIONS LÉGALES

- Du point de vue du service public, il faut que le petit producteur d'électricité soit constitué en société distincte pour entreprendre le projet.

- Pour protéger suffisamment cette société, le petit producteur doit se procurer une aide juridique et technique et se munir d'une assurance appropriée.

- Les discussions tenues entre le petit producteur et le service public doivent comprendre les sujets suivants :

  - Responsabilités de chaque partie;
  - Droits de chaque partie;
  - Calendrier du projet, approbations, construction, installation et mise en marche, durée du contrat, options de renouvellement;

Sommaire

  - Puissance et conditions d'interconnexion;
  - Calcul des tarifs;
  - Conditions de paiement;
  - Responsabilités en matière d'exploitation et d'entretien;
  - Mesure, contrôle de l'énergie électrique.
- Les domaines suivants peuvent soulever des problèmes légaux :
  - Méthodes de calcul de la valeur de l'énergie électrique;
  - Conditions de paiement;
  - Facteur d'utilisation;
  - Garanties de rendement;
  - Calendrier du contrat et des dispositions en vue d'un renouvellement.
- Le petit producteur d'électricité doit voir à ce que :
  - Le gouvernement fournisse les approbations appropriées;
  - Une assurance lui soit consentie;
  - Le réseau soit exploité et entretenu de façon adéquate;
  - Les fabricants fournissent des garanties.
- La responsabilité de l'inspection et de l'approbation de l'installation repose généralement sur le service public.
- Le petit producteur doit acquérir le droit de passage pour toute transmission d'énergie électrique devant être effectuée. Tout autre obstacle légal à l'installation doit également être identifié et traité.
- Le petit producteur et le service public doivent prendre une décision au sujet des responsabilités légales en cas de panne d'électricité du réseau du petit producteur.

1.0 OVERVIEW

1.1 INTRODUCTION

The production of electric power from small-scale, independently installed and operated power systems is relatively new in Canada. In recent years small-scale wind and hydro systems have been installed across the country, and several have been installed to serve Canada's remote communities. These systems have been installed by small, private power producers (see glossary) intending to produce electricity. In the past, only provincial or territorial utilities, and departments such as Indian and Northern Affairs Canada have been involved in the provision of power to Canada's remote communities.

1.1.1 Purpose

This manual is intended to facilitate the development of power sale and purchase agreements between small power producers and utilities who provide energy service in remote communities. It is based on small-hydro or wind power systems. In certain cases, a remote community may itself wish to become a small power producer.

Other renewable systems (i.e. photovoltaics and biomass) are not covered in this manual because they are presently not considered to be economical for remote communities, but the same considerations apply.

The potential for this type of remote power system in Canada is great. There are over 300 remote communities across the provinces and the territories and most of them derive their electricity from costly diesel generating systems. Many of the communities have sites with small-scale hydro or wind potential

A typical remote community - Makkovik in Labrador

near them, and the purpose of this manual is to facilitate the relationship between private installers and utilities so that they may work together to develop the potential of these sites.

Experience has shown that remote power projects are not easy to organize. Many factors must be taken into account to ensure the success of a project, and there are barriers to overcome which can impede the implementation of a project. These factors will be discussed in the manual in order to encourage productive discussions between small power producers and utilities. Each step of the way, there are basic things to do which relate to project management, financial and economic analyses, legal considerations, and other factors. This manual outlines potential concerns and interests, and suggests possible solutions.

1.1.2 Scope/How to Use this Manual

This manual presents an overview of the project development process involved in the sale and purchase of power. It focusses on the remote community and does not attempt to deal with grid connected systems. It reviews the interests, concerns and activities of the small power producer and the utility. It is designed to assist these parties in understanding the other's perspective and to indicate to each how to approach the other.

This manual is not intended as a technical manual. Basic technical information on wind and small-hydro systems is, however, provided in Appendix E. Further technical information may be obtained by reviewing studies, project reports, documents and other information from across the country, such as small-hydro and wind power project reports. In addition, three case studies of new remote small-hydro and wind installations are presented in Appendix F. The case studies convey project history, interests and concerns, rather than technical data. Where energy output data is available, it is presented. For more information, contact the nearest Energy, Mines and Resources Canada Programs office.

1.2 BENEFITS FROM SMALL POWER INSTALLATIONS

There are many possible benefits to remote communities from small-hydro and wind installations.

1.2.1 Reducing Cost of Generation to Utilities

An important benefit to remote utilities and one of the major justifications of such installations is the lowering of electrical generation costs. Currently, diesel generation costs range from 7 cents per kilowatt hour at the lower end, to 60 or 70 cents per kilowatt hour at the high end. Small power producers can reduce these costs by signing sale of power agreements with the utilities.

These cost reductions may influence the utility's ability to offset the deficits involved in power subsidization to the communities. Furthermore, there is the potential for shared benefits among the small producer, the utility, and the community.

1.2.2 Deferral of Plant Expansion

Small, privately owned power systems can reduce the need to expand conventional diesel plants to meet growing loads. There is also evidence that in communities with locally owned renewable energy systems, load growth and energy consumption can be reduced because of increased public awareness of conservation.

Another factor to take into account is that with load management techniques, diesels can be made to operate more efficiently, and this generally increases their lifespan. Increased efficiency can also be achieved by reclaiming and using waste heat from the diesels or by using more efficient diesel systems as old installations require replacement.

1.2.3 Reduction of Environmental Problems in Communities

The storage and burning of diesel fuel creates environmental problems in many communities. These problems include such things as oil leakage from faulty transfer and containment systems, the release into the atmosphere of the products of diesel combustion, and empty oil barrels which are left in or near the communities. Any reduction in the use of diesel fuel will help reduce these environmental problems.

1.2.4 Potential Reduction in Cost of Power to Consumers

Small power installations can potentially reduce the cost of electricity to commercial, institutional and residential consumers in the communities. In many remote communities, however, the utility does not charge the full cost of generation and the consumers are considered to be subsidized for their power use. In this instance, small power installations which sell power exclusively to the utility will not result in savings to the community. In cases where the small power installation is owned and operated by the community, benefits will accrue which may have significant, positive impact on economic development in the community. In either case, the development of such installations can create local jobs in the construction, installation, operation and maintenance of the systems.

1.2.5 Small Power Producers' Business Opportunities

The small power industry in Canada would benefit from the sale of equipment, and significant entrepreneurial opportunities exist in the sale of power agreements to the utilities. Indeed, remote installations represent one of the best business opportunities for the small power producer because the purchase price for the power is likely to be much higher and the economics of the installations more favorable than in the southern market. Currently, power sales can be made at substantially higher rates in remote communities than in the southern part of the country. There is a debate concerning the method of calculating the worth of the power from the installations. Should it be based on a shared savings concept, on a calculation of avoided cost in that location, or on a calculation of full avoided cost (what it would cost the utility to generate power from a new utility installation in that location)? At the moment, there is no standardized technique for valuing the power from these installations, and the methods used vary from utility to utility. As these methods are in a state of flux, the small power producer should check with the utility and regulatory authorities to determine what he will be paid for the power.

1.3 PERSPECTIVE OF SMALL POWER PRODUCER

To the small power producer, remote installations represent an excellent business opportunity. The territory is somewhat unknown because not many installations of this nature have been established. The small power producer is careful to keep installation costs low, and is interested in obtaining a reasonable rate for the power. This rate is usually related to the current utility costs of generation, and is site specific. Once a potential site has been identified, the small power producer may ascertain how much it currently costs the utility to generate in that location. In the case where there is no current power system, some other means of evaluating the worth of the power must be adopted. It should be understood that the small power producer is looking for as favorable an arrangement for the sale of power as possible.

1.4 UTILITY PERSPECTIVE

The utility is motivated by the potential for savings. However, its responsibility to the communities, and to its own employees also affects how it interacts with the small power producer. The utility is interested in both the quality and reliability of power coming from the independent installation. It is also interested in minimizing the negative impact of the installation on its own equipment and the revenue from accounts in the community. Because community loads vary widely throughout the day and the seasons, the impact of reduced loads on the diesel generators can be great. As a result, many factors must be taken into account, and these factors differ depending upon whether one is considering wind, or small-hydro installations. Small- hydro input for community use is relatively steady and predictable. Wind input is not as steady as small-hydro, and therefore results in variable input to the community system, which may cause problems in operating and scheduling the diesel generators. Various types of storage may be used to minimize this problem. Controls

must be modified to optimize operational efficiency of the whole system, with consideration to maintenance, minimum permissible load on diesel generators and possible load management techniques.

The utilities have been in the position of being the sole provider of power in the remote communities. Some are at varying stages of developing acceptable arrangements with small power producers.

1.5 BENEFITS OF EARLY COOPERATION BETWEEN UTILITIES AND SMALL POWER PRODUCERS

There are many benefits to be gained by the small power producer and the utility working together right from the start of a proposed installation.

The first benefit is that these key actors get to know each other. Working together, both parties have the opportunity to develop a mutual understanding which can lead to a beneficial relationship, and respect for each other's needs.

The second benefit is the sharing of knowledge and experience. This is to mutual advantage because the expertise in generating power and keeping costs down resides both in utilities and in the private sector. The combining of skills will usually lead to a better, more mutually beneficial installation particularly if contacts are made early. This way technical details and an approach to the installation can be worked out together although the utilities do not normally take the lead. There is more time to investigate the situation and present proposals for designs and contractual arrangements. Early contact will likely optimize the benefits of a particular project, and will provide the time needed to review proposals, tender for civil work and equipment, and deal with various permits and approvals.

1.6 POWER SALES AND PURCHASE AGREEMENTS

Utilities and private power producers are concluding agreements across the country for grid connected installations, and several agreements between small power producers and remote utilities have recently been concluded. Examples of recently concluded agreements are discussed in Appendix F, Case Studies, and in Chapter 3, Financial Considerations. As the experience grows, so does the ability of utilities and small power producers to work together. This guide is intended to facilitate relations that could lead to the spread of these developments.

2.0 PROJECT MANAGEMENT CONSIDERATIONS

This chapter addresses elements of the project management process from the points of view of the small power producer and the utility. It suggests means to facilitate cooperative approaches and to minimize any potential surprises that might arise. A flow diagram of the typical project management process followed by a small power producer is presented as Exhibit 2.1.

2.1 REGULATIONS, BY-LAWS, CODES, AND POLICIES

Each area of the country has regulations, codes, and by-laws to which small power producers and utilities must usually adhere when installing a remote power system. The existing regulations may, however, need to be changed if they are inappropriate for small power production. This situation has occurred recently in Newfoundland where regulations regarding the utility's exclusive rights to use water for power generation, and regulations regarding the Public Utilities Board have been changed to accommodate small power installations under one megawatt.

The small power producer should also be aware of government and utility policies. These vary from region to region but usually cover the following areas:

- safety
- environmental protection
- civil, mechanical and electrical standards
- rights of way access for transmission and distribution of power
- utility policies on interconnection and the purchase of power
- government regulations on the taking of water

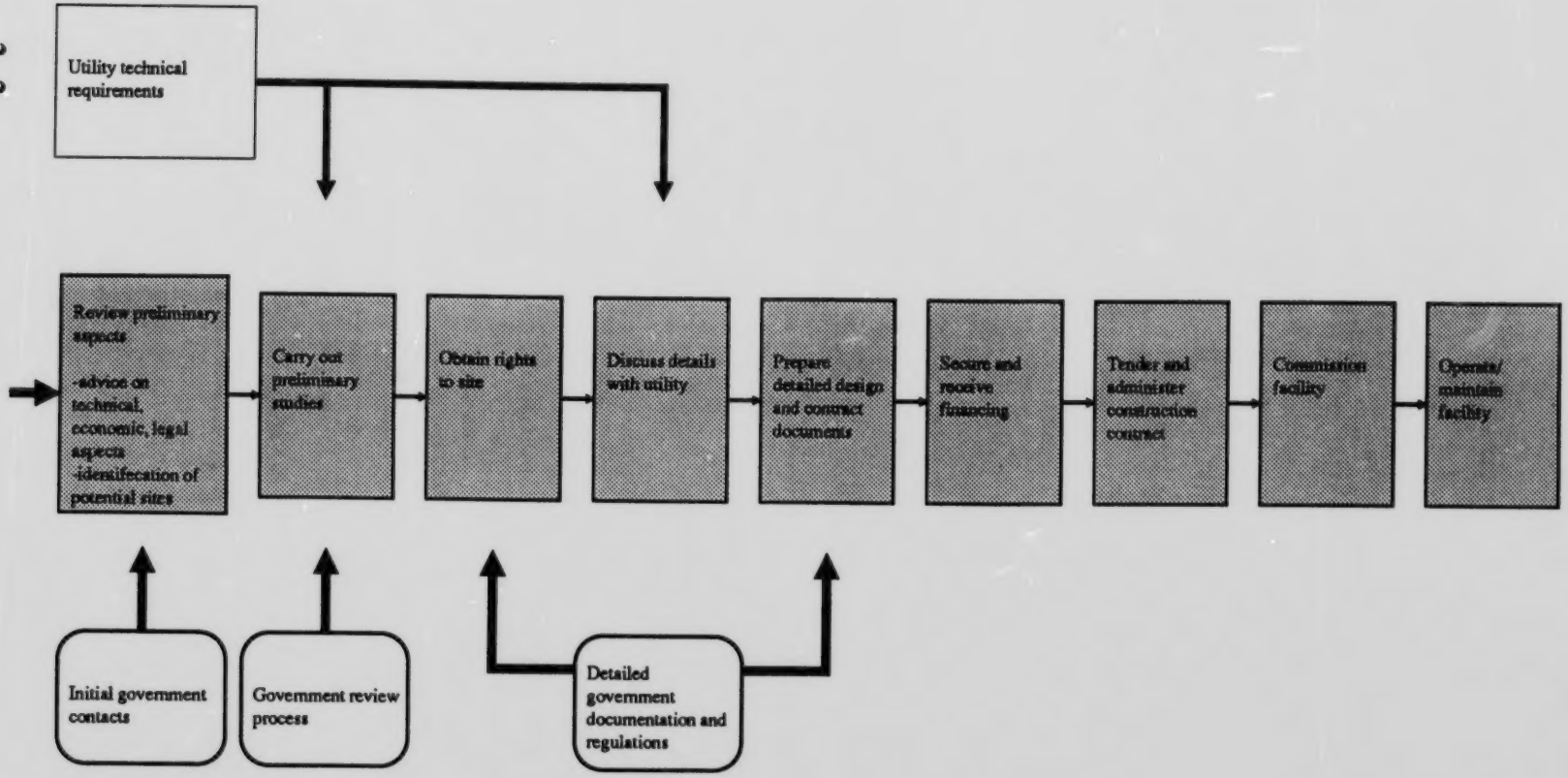
See Appendix A for a summary of Utility Policies, Rates, and Service Conditions, and Appendix D for a summary by province and territory of the Government Approvals Process.

Installed equipment must meet the Canadian Electrical Code and Canadian Standards Association (CSA) or equivalent standards. The small power producer should verify this when selecting and installing equipment, since it could result in lengthy delays at later stages of the project when commissioning and inspection of the equipment occur. It is also advisable to obtain the appropriate legal and technical advice. In most if not all jurisdictions in Canada, technical advice from licensed professionals and the approval of construction documents is a statutory requirement.

Some utilities find it useful to provide small power producers with a package of materials describing the policies, procedures, regulations, standards and codes that must be met to obtain approval for an installation and to pass an inspection of the system. This will assist the small power producer in understanding the utility's policies and the safety and power quality specifications that must be met.

EXHIBIT 2-1

THE DEVELOPMENT OF REMOTE, RENEWABLE POWER: THE SMALL POWER PRODUCER'S PROJECT MANAGEMENT PROCESS



2.2 ORGANIZATION

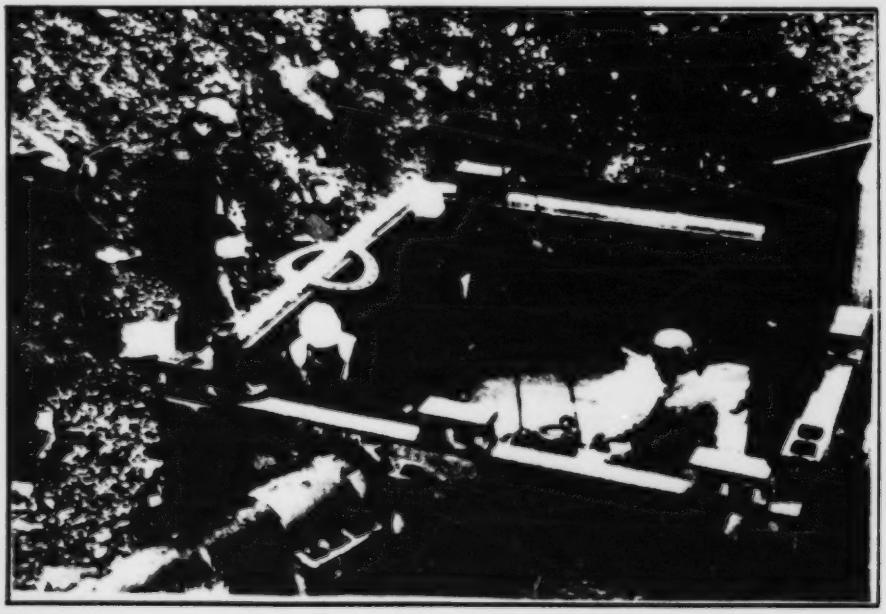
Many different players are involved in every installation: the small power producer, the community, the utility, the construction crew, government agencies, inspectors, and perhaps regulatory boards. Many different activities are also involved: the development of engineering plans, the coordination of submissions, negotiations with the utility, and the ability to develop credibility with the utility and government agencies. Whether the system is wind or small-hydro, large or small, strong organizational skills are critical for a successful project.

It is therefore necessary for the small power producer to carefully think out the type of organization that is necessary to deliver the project before contacts with the utility or government agencies are made. It is also necessary to hold discussions with a wide range of actors prior to finalizing an organizational framework for the project.

It is equally important for the utility to think out the team structure that it uses to deal with small power producers and it will become increasingly important in years to come when more remote power proposals are put forward. Several utilities have developed sophisticated means of evaluating incoming proposals, and in one case over twenty five departments in the utility review the proposals.

In any event, it is necessary for the small power producer to form a legal entity. The purpose and structure of the legal entity depends on the intent and needs of the developer.

Utilities are generally skeptical about the abilities of small power producers. The presentation of a strong, well organized corporate organization can improve the utility's impression of the small power producer.



Construction of the powerhouse at Frontier Lodge, a remote small-hydro installation

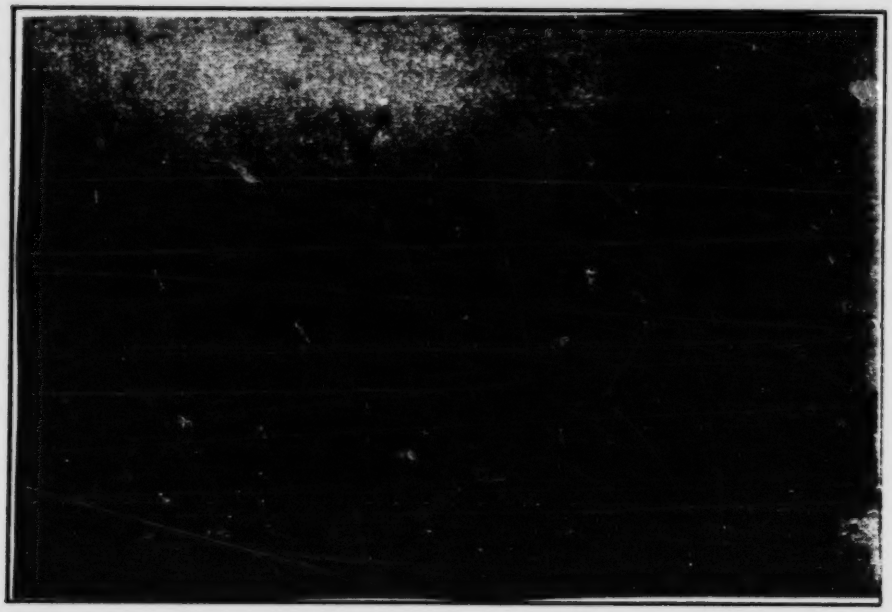
2.3 PROJECT OBJECTIVES

The small power producer's overall objective is to have a smooth running operation. This means that care must be taken to anticipate all possible problems.

The utility's objectives may be to increase the security of power supply to the community, or to save money by purchasing lower cost power from the small power producer. The utility, however, is always concerned that the new, small power system may turn out to be less reliable or more expensive than conventional diesel generation. They are also concerned about being inundated with proposals by small power producers who are not familiar with remote community operations.

The community's objective is reliable power at a reasonable cost. The small power system may reduce the cost of energy to the community and it may increase the overall level of power available. These are two distinct advantages to the community.

At the moment, there is no generally sanctioned method to determine the worth of the power from a small, private installation. Instead, the utilities formulate their own methods for calculating the rates they will pay for power, and these differ from utility to utility. The rates may also vary within the jurisdiction of one utility because the generation cost may vary from community to community.



Completed wind installation in Hall Beach, Northwest Territories.

2.4 COST SHARING ARRANGEMENTS AND FINANCING

One of the current impediments to the installation of remote power systems by small power producers is the difficulty of obtaining funding. Financial institutions are only now becoming familiar with these investments, and the general reaction has been extremely conservative. One way to overcome this obstacle is to arrange cost sharing with other funding sources. Cost sharing with various levels of government, the utility, or communities may transform a marginally economic investment into a good one. Ideally, however, the project should be economically viable without any subsidies from government. In fact, this may make the difference between a project going ahead, or being cancelled. In a recent case, a small power producer approached a provincial development corporation for a loan. The initial reaction was negative. However, after obtaining cost sharing from other government sources, the small power producer was able to convince the provincial development corporation to loan the necessary funds, and the installation went ahead.

Low cost loans, loan guarantees, performance guarantees, shared savings financing and government incentives may also be alternatives for the small power producer to explore.

A possible avenue is for utilities to explore funding options for themselves. Loans from the utility to the small power producer may be a way for the utility to gain back some of the capital outlay in terms of purchase of power from small power producers. It may also be a way to encourage the development of low cost alternatives to diesel generation in the communities. The utility would gain by purchasing lower cost power than it can generate itself, and from interest payments on the capital loaned to the small power producer. In this latter case, the utility could derive revenue and savings at the same time.

Generally speaking, investors are reluctant to fund a project which has over a seven year payback. A two or three year payback will almost ensure the acquisition of capital.

If the small power producer forms a utility, and is able to sign long-term sale of power agreements with the utilities or communities, the climate for investment is favorable.

The small power producer must also prove the reliability and life-cycle duration of the equipment involved and this is different for wind and small-hydro equipment. Small-hydro equipment is usually the longer lived and may at the present time be the easier to obtain funding for.

2.5 DIVISION OF RESPONSIBILITIES

Both the small power producer and the utility have a variety of responsibilities which may vary at each stage of the development process. Initially, the small power producer and the utility may share the responsibility of identifying viable projects within their jurisdiction. Utilities, however, do not normally lead the way.

The small power producer can review existing information relating to the renewable potential close to the remote communities. The utilities and govern-

ments may have already produced overview studies of potential sites and the sharing of this information can save a lot of time and effort. This initial site identification is critical to the evolution of sound installations which will be to the mutual benefit of all those involved.

At the design stage, the small power producer must comply with electrical codes and power quality specifications. Experience has shown that innovative design can keep costs down and environmental impact minimal.

Both the small power producer and the utility could work together to ensure sound practices during the construction phase of the project. Close monitoring of civil work by the small power producer can prevent the potential loss of time at later stages in the project, particularly where local contractors are left on the site to complete work.

If the construction and installation process is adequately planned for and monitored, commissioning of the installation should proceed without undue problems. The small power producer must ensure the power quality and output from the installation, and the utility must ensure the safety of both its staff and community members.

Adequate protection from vandalism should be provided for the installation. Particular care should be taken to make the intake structure of small-hydro installations safe. The site for a wind power installation should be adequately fenced off. These items are the responsibility of the small power producer.

Recent experience suggests that a clear delineation of responsibilities from the outset contributes to a well organized project. Appendix F describes a remote wind farm installation in which the responsibilities between the utility and the small power producer were clarified from the outset. The project has proceeded without encountering major obstacles.

2.6 RECOMMENDED POWER OPTION

The criteria for the selection of the preferred power option are critical to the success of a remote power installation. Several options may be available to the small power producer. The small power producer must consider many issues. Is the renewable source reliable and large enough to replace diesel generation or should it be used only to supplement diesel power? If a reliable source of water-power is available year round, how much power could it produce? What is the most cost-effective level at which to install? If wind is a serious option, how large an installation should it be?

Consideration of cost and payback is essential to this decision. At what cost can power be generated and what level of power can be provided? What maintenance and operation costs are expected? What previous records of reliability for the equipment are available, and what is the life span of the equipment being installed? These considerations are critical to a remote installation, particularly where transportation costs may be significant. Careful consideration of operation and maintenance costs must be included in the decision of the recommended power option. Experience has shown that this cost alone can make or break the economics of an installation.

Problems have occurred where utilities have not been convinced of the reliability and cost effectiveness of a particular technology. In one recent case it took six years to convince the utility to install a technology, and they have required the small power producer to retain 50% equity in the project for a period of two years before they will agree to own and operate the installation. In another, a utility has signed an agreement to purchase power "at will" but has required the small power producer to operate and maintain the system for a two year period, even though the utility maintains a diesel operator in the community.

2.7 LIMITATIONS

Many limitations may have an impact on the development of a remote power installation. The first is the limitation of the renewable source itself. The average velocity of the wind, or the available head and flow of a hydraulic installation set obvious limits. Both the small power producer and the utility must judge whether the resource is sufficient to make an installation economically feasible and attractive to all parties.

The proportion of alternative energy to the existing diesel system and the size and characteristics of the diesels must be taken into account when interfacing with the diesels. These considerations are different for wind and small-hydro installations.

Small-hydro output normally fluctuates seasonally and in relation to patterns of rainfall, whereas the output of wind power can be highly variable from hour to hour. This makes small-hydro input easier than wind power to integrate into a local diesel grid. The need for dump loads, such as electrical resistor banks or hot water heating tanks, that can absorb the excess energy produced during peak production may need to be considered.

Diesel engines can be seriously damaged if they are operated on widely fluctuating or low loads. Fluctuating power input can cause major problems and is the frequent cause of diesel breakdowns.

Utilities are justifiably concerned with the offloading of diesels from renewable input, and they carefully consider the degree of penetration of the existing grid. It is therefore important for the small power producer to discuss these aspects of the project with the utility before designing and installing a system. In a recent installation, a small power producer has asked a utility to downsize its diesel installation in a community to allow a small-hydro unit to take more of the community load. The utility has responded positively because they have a smaller diesel in stock which fits the requirement, and they will replace the diesel when it is convenient for them to do so.

Logistics of construction, the transportation of materials and equipment, the availability of local construction crews, their level of skill, the availability of construction equipment, and environmental conditions all place limitations on project management, scheduling and cost. The building season in remote communities is usually short. This may impact dramatically on construction and equipment delivery time. Innovative planning and the provision of a temporary shelter on site may be required. Another consideration is that certain

sites are accessible only by scheduled carriers. If a planned delivery is missed or additional materials are needed, this can have a serious impact on the schedule of the project.

Another important limitation to the design of projects, particularly in the area of wind, is the cost of travel for maintenance or repair purposes. Frequently, the utility is the only technical resource on site.

2.8 PROJECT APPROVAL

Contact between the small power producer and the utility should be made early. From that point on, a two fold process is likely to occur; there will be an exchange of technical information, and contractual negotiations will occur. Each utility and province or territory has its own procedures with which the small power producer must comply (See Appendices A and D of this manual). Certain utilities have well developed policies that apply to small power producers, some are developing policies, and others have none. This leaves the onus on the small power producer to investigate the utility's policies and the government approval process. There may be problems in areas of the country where small power producers wish to install systems, but utilities will not purchase power.

2.9 GUARANTEES

The area of guarantees in the delivery of remote power projects is an important one. Both the small power producer and the utility need to be assured of the delivery and start-up times of an installation. This is particularly important when it may have an impact on the delivery of power to a community. A slippage in time may also affect the small power producer's cash flow.

The area of guarantees also involves equipment performance. The small power producer should be assured of the performance characteristics and output of the equipment being installed by obtaining a performance guarantee from the manufacturer. The mean breakdown time (MBT) or length of repair free operation time of the system should be investigated by reviewing the history of repair and maintenance on similar installations elsewhere. This also applies to the supply of replacement parts and equipment. The small power producer and the utility should both be interested in supply and service arrangements when organizing an installation.

2.10 POST-CONTRACTUAL RESPONSIBILITIES

The signing of a purchase of power agreement should not reduce the contact between the small power producer and the utility as post contractual responsibilities exist on both sides. The small power producer is responsible for the power quality of the installation, for monitoring and operation of the system, and often for maintenance and repairs. This responsibility must be taken seriously as it is not just cash flow which may be impacted upon; it may also be the delivery of power to a community.

The utility is also responsible for maintaining relations with the small power producer on an ongoing basis. With mutual respect, the chances of a successful long-term arrangement are excellent.

3.0 FINANCIAL CONSIDERATIONS

This chapter presents an overview of the elements involved in financing small power installations, discusses two approaches for carrying out financial analysis of small power projects, and reviews facility development agreements and means of computing power purchase price.

3.1 FINANCING OPTIONS

There are many possible models for financing small power installations. This section reviews the most promising options.

3.1.1 Options for Utility and Private Producer

Both the small power producer and the utility have the option of financing installations. Some utilities may prefer to identify the financing available to engage a small power producer to deliver a turnkey installation to the utility for ownership. In this case, the utility could allocate the funds out of its capital expansion budget, or it could borrow the capital at preferred utility rates. The utility could determine its internal rate of return on the project funds based on savings obtained over diesel generation costs, thus justifying the capital outlay with identifiable revenue (savings).

Some utilities may prefer to simply purchase electricity, while others may prefer to do the installations themselves.

The small power producer does not normally have a large capital fund to draw upon, and consequently must approach financial institutions with a carefully prepared business plan. Banking institutions, including the Federal Business Development Bank and venture capitalists, all require a detailed multi-year business plan including a year-by-year cash flow analysis (see section 3.2 of this chapter). With this plan in hand, the small power producer may be able to obtain loans from chartered banks, trust companies, business development banks, provincial business development corporations, or private venture capitalists.

In a recent small-hydro development at Mary's Harbour, Newfoundland, the small power producer obtained government funding for part of the funds, approached the provincial development corporation for a loan, and put up part of the funds itself. Discussions are underway to allow Mary's Harbour residents the opportunity to purchase shares in the development.

Since these remote power installations are in an early stage of acceptance, it is still difficult to obtain funds. The situation will be better when utilities make known the rates at which they would purchase power.

3.1.2 Financial Regulations/Constraints

There are no regulations which prohibit or severely limit the allocation of capital to such projects. Careful study of federal and provincial income tax regulations may influence the design of the project. There may be income tax exemptions for certain portions of the process such as manufacturing components.

Normally venture capitalists and banks compare the rate of return of capital funds on these projects to what they can obtain from other projects in the

market place. If the rate of return from the small power development is not as favorable as can be obtained elsewhere, they are unlikely to lend funds. Generally speaking, an installation with a five year payback or twenty percent internal rate of return will be looked upon favourably by the financial community.

3.1.3 Assurances to Utility

The small power producer must be prepared to demonstrate to the utility that it is financially capable of undertaking the project. Assurances, such as a willingness to sign a long-term contract, may also help assure the utility that the small power producer will meet its responsibilities in the long- term.

3.2 FINANCIAL ANALYSIS

Payback analyses have to be conducted by the small power producer as well as by the utility in order to determine the financial feasibility of the sale/purchase of power. The objectives of the payback analysis differ for the small power producer and for the utility. The small power producer is concerned with the financial feasibility of the small scale, independent power system. In assessing feasibility, the small power producer will measure the financial return on investment and the risk related to the ownership and operation of the generating installation. The small power producer compares the expected return on investment and potential risks to alternative, available investments. The utility, on the other hand, compares the financial feasibility of operating the existing (or new) diesel generating system versus having a private developer owning and operating a small, renewable energy plant with back-up by a diesel generating system.

3.2.1 Small Power Producer's Financial Analysis

The payback analysis that best serves the small power producer's objective is discounted cash flow (net present value, internal rate-of-return).

The discounted cash flow method compares the revenues and expenditures generated by the investment in present value terms. The analysis is usually carried out for a period of years that reflects the expected time that the small power producer will hold the investment.

Under this method, estimates of all revenues and expenditures over the investment holding period have to be forecasted. This requires the small power producer to make assumptions about capital investments, operating revenues and expenditures, financing or debt cost, special tax treatments, probable market value of the investment at the end of the holding period and the discount rate to use.

Another way of measuring the financial feasibility of the project is by calculating the internal rate-of-return on equity (total cash flow). If the internal rate of return on equity is higher than the required rate of return on equity, the project is considered feasible. This technique is to be used only by those experienced in the interpretation and application of the IRR analysis.

EXHIBIT 3.1

PURCHASE OF POWER AGREEMENT ALTERNATIVES

TYPE OF AGREEMENT	PARTICIPANTS IN DEVELOPMENT/USE PROCESS			
	Options	Small Power Producer	Utility	Community
1. Short-Term Power Agreement	A)	Constructs facility, proves reliability and availability over a 2 year period. Sells power for 2 years.	Utility purchases power for two years, then purchases installation.	———
	B)	Constructs facility, proves reliability and availability of power over a 2 year period. Sells power for 2 years.	———	Community purchases installation after 2 year period of demonstrated reliability.
2. Long-Term Power Agreement	A)	Small power producer installs, continues to own and operate with option to renew the purchase of power agreement.	Utility buys power at a price fixed by formula with options to renew the purchase agreement.	———
	B)	Small power producer installs, continues to own and operate with option to renew the purchase power agreement.	———	Community buys power at a price fixed by formula, with option to renew the purchase agreement.

3.2.2 Utility's Financial Analysis

The utility tends to use either the discounted cash flow method or life cycle costing to evaluate the financial elements of a project. The analysis normally considers other alternatives. It also takes into account such costs as community carrying costs (administration, distribution of power etc.) and may include the costs involved in operating less efficiently because of lower diesel loads.

Specific small power producers and utilities may modify these analyses depending upon their particular objectives and outlooks. By being aware of different financial requirements and analyses, the small power developer and utility can analyze the alternatives from each other's viewpoint and thereby get a better understanding of each other's economic position.

3.3 CONTRACTUAL ARRANGEMENTS FOR DEVELOPMENT OF FACILITIES AND PURCHASE PRICE OF POWER

The small power producer and the utility usually set out in a contract the agreements they reach for the development of generating facilities and for the method of calculating the purchase price of power.

3.3.1 Types of Facility Development Agreements

Two basic types of facility development agreements are possible:

- Short-term;
- Long-term.

The nature of the agreement depends upon the length of time that the small power producer retains ownership of the renewable energy facility, and who takes over ownership if it is transferred.

- Short-term: In this type of agreement, the small power producer installs the facility and demonstrates the availability and reliability of power over a period of, for example, 2 years. At the end of that time period, the small power producer may sell the facility to the utility or to the community. In this case, the ultimate purchaser of the facility has a significant period of time to review performance and potential problems. The producer may develop additional sites with the cash from the sale.
- Long-term: In this type of agreement, the small power producer installs the facility and continues to own it. The producer may sell the power to the utility or to the community, possibly at a price fixed by formula with options to renew.

These arrangements are summarized in Exhibit 3-1.

3.3.2 Power Purchase Price

Although experience with setting of rates for small, renewable, remote power installations is limited, three general types of rate structures have been suggested to date. These include:

- Shared savings: In this option, the small power producer and utility (or community) determine their respective costs to produce power. The rate at which the utility (or community) agrees to buy power from the small power producer is somewhere between the higher costs that would be incurred by the utility (or community) using conventional means, and the lower cost made possible by development of the small, renewable energy installation. In this way, both the utility (or community) and the small power producer share the savings achieved by using renewable energy.

- Avoided cost of power: This means of calculating the purchase price reflects the utility's current cost of generating power with existing facilities. Therefore, capital cost of those facilities is not included in the calculation.

- Full avoided cost of power: This method reflects the cost to the utility of installing new, conventional generating facilities in the subject location. Therefore, the utility's costs do reflect capital as well as operating costs.

An example of a purchase of power agreement based on shared savings is the agreement concluded for the Mary's Harbour installation in Newfoundland. An example of an agreement based on avoided cost is the agreement between Norwester Energy Systems and the Northern Canada Power Commission for the wind installation in Cambridge Bay, Northwest Territories. No agreements have been concluded on a full avoided cost basis.

In certain cases, there may be no existing system in the community. If this is the case, the small power producer will have to estimate the value of power in that location.

The small power producer and the utility both have interests and concerns about the method used for valuing the power and contractual arrangements.

Small power producers are interested in maximizing their profit and have therefore supported the use of a formula based on full avoided cost. This is defined as cost to the utility of installing a new generating system in the specified location. Utilities, on the other hand, want to limit the price they pay for power and so have tended to prefer a formula based on avoided cost. While this has many definitions, it is most often based on avoided fuel cost or avoided fuel and maintenance costs.

Small power producers have also expressed concern with certain conditions included by utilities in the contracts. An example is the differential payment associated with systems functioning at different capacity factors. What this means is that the utility may pay one rate for a system which functions at a capacity factor under, for example 65%, and a higher rate for a system functioning at more than 65%. If this method of payment is applied on a month by month basis, when a system drops under the 65% capacity factor in any month, the whole payment for that month is based on the lower figure.

4.0 SOCIAL AND ECONOMIC CONSIDERATIONS

Job creation, reduced power costs, and increased economic development are potential economic and social benefits that flow from remote, renewable energy projects. These elements, along with associated interests and concerns, are briefly reviewed in this chapter.

4.1 JOB CREATION

Job creation may be the most immediate benefit of remote power installations. Although the opportunities are largely short-term, they may initially contribute to the community's decision to approve the project. At the earliest planning stages, there are roles that local residents can play. These roles, under skilled supervision, include gathering site data (wind, water flows) and environmental characteristics. During construction, jobs may be created such as operation of heavy equipment and other site intensive tasks. This work can be done by local labour, but care must be taken to provide adequate supervision. Jobs may also be created to operate and maintain the system; however, this rarely takes more than one person, so the long-term job creation potential is low.

In one recent installation, a utility has been contracted to operate and maintain a wind power system for a small power producer. No jobs were created or lost. In another, the small power producer is responsible for operation and maintenance of the system over a two year period of time, at which point the utility will assume ownership of the facility. In this case, the job creation potential is only temporary. In a third case, local labour was used during installation of a small-hydro system, and a local operator has been hired part-time.

4.2 REDUCED GENERATION COST

If a small power producer provides power directly to the community, the community could possibly benefit from lower generation costs than it would pay if the utility supplied power. Although such a benefit may not always be possible for residential consumers (these rates are usually low even when power is provided through a utility), it is more likely that commercial and institutional users could pay less. This might enable the start up of small businesses that would otherwise be uneconomic. It might also lower the carrying costs of institutional buildings in the community, thereby making additional funds available to raise the level of service.

If a small power producer installs and sells power to a utility, it is unlikely that the community will benefit from a rate reduction.

4.3 ECONOMIC BENEFITS FOR THE COMMUNITY

Reduced generation costs could result in more capital being available in the communities, which could be used to increase economic activity and contribute to raising the quality of life. The greater the amount of power provided in remote communities, the higher the quality of life. Experience has shown that if unlimited power is available, consumption will rise to between two and ten times the previous level of use. This increased consumption relates pri-

marily to the use of more appliances and the start up of small businesses. Increased use of appliances and a greater choice in goods and services have a beneficial impact on the quality of life in the community. Improving the quality of life in remote communities in Canada is an extremely important issue at this time.

By emphasizing the improvement to the quality of life in remote communities, small power producers can advance their case for community support. This understanding can help promote a growing interest in development of renewable energy projects in isolated communities across Canada. It may also provide the impetus for governments to provide funds to support renewable, remote power projects, through the provision of capital grants or low cost loans. This should stimulate private sector and community initiatives.

In certain situations, it may be advisable to conduct a study which measures the external benefits of a project. Such a study may be required by regulatory agencies if a power purchase has not been established.

5.0 TECHNICAL CONSIDERATIONS

This chapter highlights the important technical areas which should be considered when developing a remote power project. It is meant to raise engineering concerns but not solve engineering problems. The following topics are covered:

- feasibility studies and concept plan;
- planning;
- design, system selection and performance;
- installation, and;
- commissioning.

5.1 FEASIBILITY STUDY/CONCEPT PLAN

One of the most important steps in the development of remote power installations is the development of a sound concept plan. This overall plan is normally the responsibility of the small power producer and focusses on the selection of an appropriate community and system. It is based on a consideration of a series of factors, including:

- existing energy costs;
- scale of investment to be made;
- technology to be employed;

Small-hydro turbine being prepared for shipping

- existing plant characteristics;
- existing utility policy including power purchase rates, and quality of power requirements;
- anticipated revenues;
- availability of resources, land, equipment, labor and materials.

Once this concept plan has been developed and an installation in the chosen location has been determined as viable, the small power producer should undertake a more in-depth feasibility study. This study can form the basis of a proposal to the utility. Care should be taken in its development and it may be necessary, or a legal requirement, to engage professional assistance to help put it together.

From the beginning of this process it may be possible for the small power producer and the utility to work together to produce a proposal which will satisfy both. The utilities are concerned with the technology chosen, the sizing of the system and the method of integration into the utility grid. These concerns could be discussed at this stage and an attempt made to resolve any differences. It is also desirable for the small power producer to discuss with the utility whether the intended site is appropriate for a private installation.

It may also be possible to obtain site data from previous feasibility studies. Several feasibility studies have been undertaken by federal and provincial agencies and these studies could be requested and used as reference documents.

Detailed calculations of the potential of the renewable source will have to be made. These should be based on available wind or hydrological data. If data is not available, a one year monitoring program may be necessary to obtain sufficient information to provide an acceptable estimate of the potential, annual, energy output. This estimate should be conservative. The area of power output estimates is a contentious one, and testing and verifying the figures produced should be done to professional standards. The parties should be prepared to examine the estimates using a variety of methods.

Other site characteristics may also need to be investigated. An assessment of the roughness class of the wind resource, including obstructions, trees, buildings, and other obstacles may need to be done. An assessment of the local features which may enhance wind speeds, such as hills or ridges, and proximity to large bodies of water may also be necessary. Because small-hydro installations may displace base load, a calculation of flow versus available head should be made and verified with the utility, and an assessment of the size of head pond (if any) should be made. Other site details to take into account include soil and foundation requirements and logistics such as access to the site, and distance to the utility grid or community.

In any event, the detailed feasibility study must identify the economics, technical feasibility, and environmental impact of the installation so that these issues can be addressed early on in the project development. The feasibility study should also address the potential benefits to the small power producer, the util-

ity and the community. This feasibility study can then be used as the basis for a proposal from the small power producer to the utility.

5.2 PLANNING

The area of preliminary planning is an important one for both the small power producer and the utility. Basically it is at this stage that the small power producer must prove to the utility that the development is technically sound. The utility will be looking for extremely detailed engineering documents which take time to prepare, and may be costly. Proposals may have to deal with over forty areas of concern including hydrology, environmental considerations, land tenure and water licenses, reservoir and dam, tunnels, intake structures and screens, penstock, powerhouses, transmission lines, substations, electrical details, access roads, construction equipment, engineering and surveys, administration, regulatory exemptions, construction schedules, project cost estimates, operation and maintenance, economic evaluation, and a draft of the power purchase agreement. Appendices may need to include precipitation records, storage requirements, environmental studies and approvals, a geotechnical report, a transmission line route map, a generation site plan, and company references.

The small power producer should contact the utility and regulatory agencies to determine what will be required. The utility may be in a position to provide assistance to the small power producer on a contractual basis, which may pave the way for good relations.

The small power producer should be aware that the utility may specify ways of accomplishing such things as interconnection. The small power producer may wish to put forward alternative means of satisfying the utility's requirements.

5.2.1 Site Selection

Site selection is a major concern of the planning process. The small power producer may feel that there is a viable installation near a community, and the utility may not. If this is the case, both parties could carefully review their site data, estimates of cost, and potential, and the parties could meet to discuss the matter further.

One of the major elements involved in site selection is proximity to the community. Estimates for the cost of transmission vary; however, it is generally acknowledged that transmission costs in remote Canada may range from $35,000 to $75,000 per kilometer. With renewable sources such as small-hydro, however, there may not be a choice of sites. Therefore, an installation that is, for example, four kilometers from a community may be economic, whereas one that is twenty kilometers away may not. The utility and the small power producer may debate the issue; however, the economics of the installation will dictate whether to proceed or not.

One way around this problem is for the utility to identify potential sites. In the case of the small-hydro installation at Mary's Harbour in Newfoundland, it was the utility which carried out the feasibility study and made it known that they were interested in having the site developed. An engineering firm which

was already working in the community devised an installation plan which was approved.

Oil drums have become a prominent feature in remote communities.

5.2.2 Safety

The area of safety must also be addressed in the planning process. The small power producer must maintain safety on all levels because of potential liability. Adequate protection during construction is necessary and the installation sites should be secured during ongoing operation and maintenance.

The utility is concerned about the safety of their staff and of community members. Cost cutting measures will not be considered if safety will be compromised. This particularly applies to the area of disconnection switches and backfeed to the community distribution system because the utility is concerned with their linemen working on the system.

Safety and code requirements for equipment, siting, installation, and electrical connection can be determined from CSA standards and the Canadian Electrical Code. These should be studied and reference made to them in project documents.

5.2.3 Load Profile and Practicality of Equipment

Another area dealt with in the planning process is the determination of the load profile and load growth. The small power producer and the utility may differ in their estimates of load growth. Generally speaking though, remote communities are growing slowly, and estimates of load growth can be made and checked against historical records. There is at the moment no clear formula for the determination of load growth.

A related concern is the practicality of the technology being proposed for the site and its capability of meeting the load demand that is forecast. The concern of practicality has to be carefully considered in remote power projects. While wind turbines may generate electricity reliably in warm climates, there is little experience in Arctic or sub-Arctic conditions.

5.2.4 Power Quality and Interconnection

Another area of potential concern is that of power quality and interconnection with the community distribution system. This is an area where a difference in philosophy has become apparent. Utilities have very high standards and specify equipment which is of utility quality. This relates mainly to frequency and voltage control, and intertie switches with the local distribution system. Small power producers would like to propose lower cost options which, they believe, will accomplish the same ends. The onus is on the small power producer to prove the technical capability of the controls, intertie switches and safety mechanisms that are being proposed.

If the small power producer and the utility come to grips with differences in this area, then potential problems with acceptance, commissioning, and inspection of the systems can be forestalled. The small power producer and the utility should be willing to examine each other's views and needs, and attempt to come to mutually acceptable solutions. This holds for issues surrounding sizing and capacity of the installation as well.

Small-hydro equipment being inspected prior to installation.

5.2.5 Operation and Maintenance

Operating and maintaining an installation can be a time consuming and expensive exercise if care in planning is not taken from the outset. Although diesel engines are a relatively well known technology in remote communities, small-hydro and wind turbines are less well known. Each requires its own operating regime and has its own peculiarities. Both the utility and the small power producer have an investment in keeping the installation operating and discussions should be held to determine site requirements, particularly for operating personnel. Utilities may be more familiar with operational problems in remote communities than small power producers because the utilities have been operating there for many years. They generally have no misconceptions concerning the capabilities of local staff and they understand the need for training of local operators.

The operational requirements of the system as well as regular and unexpected maintenance must all be taken into account. Provision must be made for the development of operational plans and manuals. Provision may also have to be made for regular inspection of the installations by a trained operator and it is to the advantage of both the small power producer and the utility to ensure there are well trained, operational staff. Questions can arise with respect to the capability of staff on site and the small power producer might consider contracting with existing utility staff for operation and maintenance of the system.

It is therefore in the interest of the small power producer and the utility to provide adequate training to operational staff and to provide adequate back up in the event that a problem cannot be handled by local operators. Experience has shown that operational problems, such as the shipping of replacement parts, or the repair of electrical or mechanical systems can produce long periods of down time in remote installations. These impact on the utility because the diesels must bear the whole community load, and on the small power producer in terms of the cash flow produced by an installation. A solution might be to provide a complete inventory of replacement parts and a quick method of responding to problems, such as contracting a local (or regional) engineering firm as back up for operation and maintenance of the systems.

Modifications to the existing utility operation may also be necessary. This impacts on the areas of diesel controls and safety devices and raises the question of load management. These potential sources of problems should be considered during the planning phase of the project. Costs may eventually be incurred by both sides and a formula to work out the cost sharing of these modifications should be agreed upon. A third party to these discussions could be the community itself, particularly if load management is involved.

5.2.6 Environmental Impact

Environmental impact must also be considered in the planning phase of the project. With small-hydro, potential impacts on fish populations from construction of dams and headworks, stream alterations, and the impounding of water should be included in any environmental investigation. In addition, impacts on wildlife habitat and vegetation due to flooding, and the impact of clearing trees for transmission corridors should be considered. The latter is more important

in certain areas, such as British Columbia where the clearing of very large, valuable trees may be involved.

With wind power systems, the potential impact is less and involves the size and height of the installation, potential interference with radio and television reception, and potential interference with bird populations and aircraft. Both the small power producer and the utility have a responsibility to the community to ensure minimal environmental impact.

In the case of the Mary's Harbour small-hydro installation, environmental impact was not viewed as a problem because the project was appended to an existing municipal system water intake canal. In the case of two wind installations in the Northwest Territories, environmental impact was not a factor because the systems are relatively small and no physical interference with the bird populations or aircraft was anticipated.

5.2.7 Sizing of Installation

Planning with respect to the sizing of an installation is also a potential area of concern. In the case of small-hydro, the size of the installation may be limited by the available head and flow at a site. If the site has a large capacity, discussions concerning load growth and what level of power to install are necessary. The utility may not want to purchase more power than current demand requires, so economic factors may dictate the level of power installed. The small power producer may want to consider a modular approach where units may be added to boost capacity at a later date.

There are several ways to approach the sizing of a wind installation, depending upon the load to be served. If the wind turbine is integrated with a diesel system, the convention has been to install wind capacity that is no more than 20 to 40 percent of the utility load, but this can vary from place to place. However, with the advent of load controllers it may be possible to have the wind turbine(s) serve some of the space-heat load in a community with energy in excess of what the diesels can accommodate. With this approach, the installed capacity of the wind turbine(s) could be in excess of the diesel capacity and, with a wind farm, could serve a significant portion of the space-heat load in a community. In such a case, all costs should be carefully taken into account. At the present time, the utilities believe small power producers do not appreciate the full range of costs to the utility. If the system capacity is increased, for example, then it may be necessary to upgrade the community distribution system. The small power producer and the utility may have to negotiate who pays for the upgrading of the community distribution system.

5.3 DESIGN, SYSTEM SELECTION AND PERFORMANCE

Design and system selection for a remote installation are both critical factors in the reliable delivery of power. Utilities and small power producers are both concerned about the performance claims of wind and small-hydro manufacturers. Both need to be satisfied the choice of equipment and the expected performance is acceptable. Except for the wind installation at Churchill, Manitoba, which has been operating reliably for years, utilities are concerned that no wind turbines have demonstrated mid to long-term reliability in Arctic or

sub-Arctic conditions. However, some installations have been in operation for only a short period of time in northern locations. These pilot installations should prove the reliability of wind installations in the northern climate.

The situation for small-hydro is different. The technology itself is maturing and has been installed in harsh environmental conditions successfully. There are, however, potential problem areas such as of extremely low temperatures, icing, and the clogging of intake structures which must be addressed. Generally, manufacturers' warranties and guarantees must be carefully examined and, in several recent cases, extended warranties have been provided to satisfy a utility's concerns about reliability.

The utilities have expressed a general concern with the quality of civil and mechanical design undertaken by small power producers. This highlights the need to obtain qualified, engineering input in both mechanical and civil design.

5.4 INSTALLATION

Installation of power systems in remote communities is a complex task involving the availability of equipment on site, transportation, logistics, the availability of materials such as aggregate for concrete, and the availability of local labour. These factors are different for small-hydro and wind power systems. With wind systems, for example, the problem of raising and lowering of the turbine is critical. Normally, there are no large cranes available in the community so the installer must make provision for easy raising and lowering of the tower with available equipment and local labor. For small-hydro systems, the design of civil work and location of the power house, and the size and weight of the equipment is critical.

Working in remote conditions requires a particular type of discipline; careful planning must be undertaken to ensure adequate supplies, and the arrival of equipment during times of the year when it can be easily handled and installed. Missing deadlines may delay the project by many months, could increase project costs considerably and could delay the timing of start-up, thus impacting on predicted cash flow.

5.5 COMMISSIONING

Commissioning and acceptance of the systems is the process whereby the small power producer proves to the utility that the installation is acceptable and functions as specified. The elements which are tested are usually set out in advance, and so there is little chance for misunderstandings to arise. One area where problems can occur is in the inspection of the systems for electrical conformance. If permits have not been obtained in advance, or if the electrical system does not meet standards set out by the utilities, the Canadian Electrical Code, or CSA, approval may not be given for start up or continued operation. This has just occurred to a wind installation in the Northwest Territories and remedial measures are now being taken to have the installation approved.

6.0 LEGAL CONSIDERATIONS

This chapter presents the primary legal considerations which the small power producer and the utility must consider when establishing and operating a small power installation in a remote community. It presents an overview, rather than a detailed analysis of legal requirements, responsibilities and liabilities. Where possible, options to deal with the concerns are presented in this chapter.

6.1 CONTRACTUAL FACTORS

Various factors are involved in the development of comprehensive purchase of power contracts and these factors may change from utility to utility.

6.1.1 Corporate Structure

From the utility's point of view, one of the prerequisites for successful contractual negotiations is the need for the small power producer to form a distinct legal entity, a corporation, that is easily identifiable by the utility, and that can be held accountable. The corporation can take many forms depending on the needs and wants of the participants. The small power producer who installed the small hydro system at Mary's Harbour in Labrador, for example, formed a limited partnership, Mary's Harbour Hydro. This facilitated both the development of the installation, and negotiations with Newfoundland and Labrador Hydro.

From the small power producer's point of view, involvement in contractual discussions requires that the corporation be adequately protected. This should be done through legal and technical representation, and insurance. In addition, the utility may require the small power producer to obtain a performance bond or letter of credit. Once the proper corporate structure has been established, financing identified, technical expertise retained and legal expertise obtained, then negotiations can begin.

6.1.2 Negotiations

It is important for both the small producer and the utility to consider the following areas before a productive series of negotiations can occur:

- responsibility of each person acting on behalf of each party
- rights and responsibilities of each of the parties
- time frame
  - contract duration
  - approvals
  - construction
  - installation start-up
- conditions/quality of power produced
- calculation of rates
- conditions of payment

- operation and maintenance responsibilities
- power output metering and monitoring
- options for renewal of contract, time frame

Full preparation prior to negotiations will make implementation smoother and create the necessary, businesslike climate that can help reduce the elapsed time between conception and start of power generation. Utilities typically request that small power producers submit detailed proposals for review before they take any action, and may wish to be kept up-to-date with the small power producer's progress in developing the necessary documents.

6.1.3 Potential Concerns

One concern in the contractual process may be the utility's method of calculating the rate paid for power, versus the private producer's assessment of the value of the power provided. This concern has been raised by small power producers across Canada and is a major area of contention. It is one of the key issues with which small power producers and utilities are currently dealing, and has been a major topic of a public enquiry recently held in Alberta.

Another concern relates to the utility's conditions for payment such as a higher rate for a system that operates with a high capacity factor, and a lower payment if the system output is below the specified capacity factor. This can lead to a reduction in cash flow and a longer payback period for the small power producer.

Potential concerns can also occur in the area of performance guarantees. Depending on the length of time the small power producer has been in the business, and his previous performance record, the utility may wish the small producer to obtain a performance bond or a letter of credit with respect to a particular installation. If this is the case, the cost of the bond creates an added financial factor for the small power producer to consider, but may be worth while, given the legal and financial implications of letters of credit. In any case, legal advice should be sought.

Concerns may also arise around the time-frame of the contract. The utility may wish to specify the timing of start-up, the length of time the contract covers, and provisions for renewal of the contract.

6.2 RESPONSIBILITIES/OBLIGATIONS

6.2.1 Liabilities and Indemnification

The small power producer must assure the utility that his responsibilities and obligations will be fulfilled. He is liable to deliver power to the utility at a level agreed upon in the contract, and may be penalized if the system does not perform to its minimum specifications. The small producer must also indemnify himself against potential legal actions. It is therefore important for the small power producer to obtain professional advice before proceeding with an installation.

6.2.2 Inspection

The utility is normally responsible for electrical and safety inspection and approval of the installation. The small power producer and the utility should exchange information and discuss the legalities of these two aspects of the installation early in the project.

6.2.3 Government Approvals

The small power producer is responsible for obtaining all provincial, federal, territorial and municipal approvals that may be required. (See Appendix D for an overview of the approvals process by province and territory.) These relate largely to environmental issues, the right to take and use water, construction requirements of the installations and electrical safety. Obtaining an approval may also require public participation and consultation, and this should be taken into consideration during project planning. Problems can occur as a result of oversight (i.e. not obtaining permits, etc.) or as a result of direct outside intervention (i.e. a group of citizens who wish to block the development). Usually, though, if the small power producer has filed for the right approvals and the environmental impact of the installation is negligible, he should be able to obtain the needed approvals within the normal review times allotted to such procedures.

In order to avoid loss of time due to problems with the approvals process, the small power producer must thoroughly review the approvals process prior to meeting with the utility. He should also keep each of the approvals needed throughout the process.

6.2.4. Maintenance

In most instances, the small power producer is responsible for operation and maintenance of the installation. This means that the small producer is liable for all maintenance costs incurred to keep the system in operation unless some other provision has been made in the purchase of power contract. A legal variation might be that the small power producer contracts with the utility or a local entity to provide maintenance and repair for the system. Since the utility's staff are generally the most technically capable in the remote community, this may present a viable option if arrangements can be worked out.

6.2.5 Manufacturer's Warranties and Guarantees

The owner of the installation is responsible for obtaining and verifying manufacturer's warranties and guarantees. The utility may request an extended warranty on the system, as has been the case in the two wind power installations profiled in Appendix F.

Generally speaking, manufacturers' claims regarding system performance should be carefully verified. This can be done by investigating the performance of existing installations, or by obtaining performance guarantees.

6.3 RIGHT OF WAY ACQUISITIONS

An important factor to consider in remote power installations is the siting of transmission facilities. It is the responsibility of the small power producer to

obtain environmental approvals from federal and provincial agencies. If migration routes of land mammals such as caribou, deer or moose are crossed, then an evaluation of the potential impact may need to be included in submissions to those agencies.

If approval to cross reserve land is required, then negotiations with individual Indian bands are necessary and should be handled with sensitivity. If power is merely being transmitted across reserve land, but not to a community on that reserve, then approval may hinge on the rate paid to the reserve to "wheel" power across it. If power is being provided to a community on that reserve, then approval for transmission should be easier to obtain since it is benefitting the occupants.

The small power producer must also ascertain whether there are other legal impediments to the installation of a system, such as active (Native) land claims negotiations, or litigation. If this is the case, the small power producer could investigate the situation and may have to re-assess plans as a result of identifying an insurmountable legal or political barrier. Inquiries and negotiations should be undertaken with sensitivity to the political and legal issues involved.

6.4 SUPPLY INTERRUPTIONS

Both the small power producer and the utility may want to make provisions in the contractual arrangement for supply interruptions from the independent facility. Provision may also have to be made for back up power, and the cost of maintaining this back up may be considerable. The utility may, therefore, wish to factor these two elements into the legal agreement with the small power producer. The small power producer may wish to be indemnified against actions by the community or the utility, if the utility back up power goes down and affects the output of the independent installation. This could occur if the small power producer installs an induction generator which needs power from the grid to reference its frequency and voltage output. A way around this problem might be to install a synchronous generator which is capable of generating power fully independently from the grid, but it is a more expensive option for the small power producer. In any event, both the small power producer and the utility may wish to specify in the power contract the actions to be taken when dealing with supply interruptions.

APPENDIX A

UTILITY POLICIES, RATES, AND SERVICE CONDITIONS

INTRODUCTION

This appendix presents the policies, procedures and rates which the utilities provided at the time of writing. It should be noted that these are currently in a state of flux.

This appendix and Appendix D, which reviews the government approvals process, should be used together. As indicated herein, government and utility contacts should sometimes be made sequentially, sometimes in parallel.

The following utilities do not service remote communities:

- Transalta Utilities
- Nova Scotia Power Corporation
- New Brunswick Electric Power Commission
- Maritime Electric, P.E.I.

APPENDIX A: UTILITY POLICIES, RATES, AND SERVICE CONDITIONS

ONTARIO HYDRO

Policies and Parallel Generation:

Ontario Hydro will purchase power as long as the installation is connected safely and an appropriate contract is signed with the utility.

Utility Procedures for Small Power Producers:

A developer wishing to install a remote small-hydro or wind installation should contact the Ontario Hydro Regional Office (North West Region or North East Region). The Regional Office will then contact the head office in Toronto, and will work to assist the developer towards an agreement.

Energy Rates:

Ontario Hydro is developing energy purchase rates for remote communities. A complex system of calculating rates, based on the cost of operation and avoided cost, currently exists. Rates paid are not blended for remote areas, and there may be a payment for capacity.

Metering:

Ontario Hydro supplies, installs, and reads the meters monthly. The meters are usually located with the facility. The meters are kept in locked cabinets away from the general public, but must be clearly visible to hydro employees. Meters are wired according to hydro safety regulations.

Purchase of Power Agreements:

A purchase of power agreement has been concluded at Fort Severn (60 kW wind turbine).

Ontario Hydro will react to any proposals that it receives.

NEWFOUNDLAND AND LABRADOR HYDRO (NLH)

Policies and Parallel Generation:

Newfoundland and Labrador Hydro (NLH) will purchase power from small power producers. The technical requirements are the same for wind and small-hydro installations.

Utility Procedures for Small Power Producers:

The utility procedures vary depending on the location of the installation within the province. The developer should contact, by letter, the Power Distribution District (PDD) or NLH. The PDD or NLH resolves such issues as rates, distribution, etc.

A: Utility Policies, Rates, and Service Conditions

Energy Rates:

While the general concepts concerning the rates for purchase of power have been informally agreed upon, no specific, detailed rates have been established. Rates will depend upon the size of installation, the cost of the fuel saved at a particular location, and the time the power is available. Rates are based on a shared savings formula.

Metering:

NLH, through the PDD, supplies, installs and reads the meters on a monthly basis. The cost of the meter is built into the rates. Meters must have appropriate relays, physical disconnection switches, and safety devices.

Purchase of Power Agreements:

A purchase of power agreement for Mary's Harbour is currently being executed, but is not finalized. The contract with the small power producer is for 15 years. At present, diesel generation is being used, so the rates are based on NLH paying a share of savings between diesel and hydro costs (up to 90% going to the small producer).

NLH reacts to proposals. The small power producer must provide information on safety, financial resources, and maintenance procedures.

HYDRO-QUEBEC

Policies and Parallel Generation:

Electrical connections for remote installations must meet Hydro-Quebec's standards. The policies are the same for both small-hydro and wind power installations.

Utility Procedures for Small Power Producers:

The developer sends an application outlining the proposal to the Ministry of Energy. It is then sent to Hydro-Quebec. Hydro-Quebec evaluates the proposal, and advises the Ministry of Energy concerning its acceptability.

Energy Rates:

Hydro-Quebec uses a different formula for buying and selling energy. Rates paid for power are site specific rather than standardized. The rate structure, however, is adjusted for the timing and availability of power. There is an option that allows for payment for capacity.

Metering:

Hydro-Quebec pays for metering, and reads meters every month or two. The small power producer provides the disconnecting device which can be operated by Hydro-Quebec maintenance people. Meters have to be easy to read and in an accessible location.

Purchase of Power Agreements:

Hydro-Quebec responds to proposals it receives. While proposals have been received, no purchase of power agreements have yet been concluded.

BRITISH COLUMBIA HYDRO

Policies and Parallel Generation:

B.C. Hydro is developing policies for the purchase of electricity in areas served by diesel generation and for remote installations.

Policies will be the same for both small-hydro and wind power installations. However, energy sources which are firm are favored, and therefore small-hydro would be seen as more desirable than wind.

Utility Procedures for Small Power Producers:

A small power producer should contact the Marketing Branch of B.C. Hydro, and the two work together on an agreement.

Energy Rates:

At present, energy rates are site specific rather than standardized. The rate is calculated on a shared savings basis i.e. the sum of the producers' cost and diesel fuel divided by two.

There is a ceiling of 90% of the cost of diesel fuel and there is no payment for capacity.

Metering:

B.C. Hydro pays for and supplies meters, installs them, and reads them once a month. The meters are installed in the facility, which has site specific industrial grade protection (this is paid for by the small power producer).

Purchase of Power Agreements:

Two purchase of power agreements have been concluded with small power producers.

B.C. Hydro may seek out the private sector to install remote community systems if cost savings can be clearly identified.

SASKATCHEWAN POWER CORPORATION (SPC)

Policies and Parallel Generation:

The Saskatchewan Power Corporation (SPC) has no overall policy but reacts to individual proposals. The small power producer must comply with all safety regulations.

Utility Procedures for Small Power Producers:

A small power producer wishing to install a small-hydro or wind power system must contact the Central Planning Division of the SPC.

A: Utility Policies, Rates, and Service Conditions

Energy Rates:

No rates have yet been established for the remote community context.

Metering:

SPC supplies and installs the meters, and reads them once a month. They must be installed so that they are visible and accessible.

Purchase of Power Agreements:

No purchase of power agreements have been concluded.

The SPC reacts to proposals, but does not actively seek out small power producers.

MANITOBA HYDRO

Policies and Parallel Generation:

At the present time, there are no policies for remote installations for either wind or small-hydro. Standard wiring regulations and operating procedures must be followed.

Utility Procedures for Small Power Producers:

For generation of less than 20 kW, the small power producer must apply to the Divisional Manager of Manitoba Hydro.

For generation greater than 20 kW, contact must be made with the provincial government for approvals.

Energy Rates:

There are no rates for purchase of power in remote communities. If additional capacity is needed, diesel systems are installed or the grid is extended.

Metering:

Manitoba Hydro pays for and installs one meter. The customer provides the rest, including wiring, and must read the meter once a month.

Purchase of Power Agreements:

At present there is one experimental wind turbine set up for research purposes.

The utility feels there is no demand, so therefore they don't participate in private power installations.

ALBERTA POWER LIMITED*

Policies and Parallel Generation:

Alberta Power accepts small power production as long as the cost to the consumer is not increased.

Differences in small-hydro and wind installations are based on the size and nature of fuel source. Policies have been developed for small power producers (under 2.5 MW) with a renewable fuel source.

Utility Procedures for Small Power Producers:

Alberta Power Limited assists the small power producer to prepare the necessary documentation for the Energy Resource Conservation Board (ERCB).

Energy Rates:

Alberta Power uses the principle of avoided cost to determine rates. Rates are blended; a differentiation is made between on peak and off peak power. There is payment for capacity. Actual rates have not yet been developed.

Metering:

The utility supplies and installs the meters and reads them once a month. The small power producer pays for installing the necessary protection to ensure safe and efficient operation.

Purchase of Power Agreements:

Alberta Power Limited has not concluded a purchase of power agreement for a remote community. If a project seems feasible, though, they will encourage its progress.

* *This was the position put forward during the public enquiry in 1987. This position may change.*

YUKON ELECTRICAL COMPANY LIMITED (YECL)

Policies and Parallel Generation:

YECL will purchase power if there is a saving to the customer. The small power producer would be responsible for any capital charges required to interconnect.

Policies are the same for small-hydro and wind installations, but projects are looked at individually. The utility feels that small-hydro provides more reliable power than wind.

Utility Procedures for Small Power Producers:

Small power producers must submit a proposal to the Yukon Electrical office. This office will guide the small power producer through procedural matters.

Energy Rates:

There are no standardized rates for the purchase of power in remote areas, and none are being developed. The rate paid for energy is based on the principle of avoided cost.

The small power producer will be paid according to the savings created by the particular installation. Payment for capacity is a function of whether or not energy is available at peak periods. Since small-hydro is seen as more reliable than wind, it may get payment for capacity.

A: Utility Policies, Rates, and Service Conditions

Metering:

Metering (by the utility), is done at the facility every two months. Payment for metering is calculated in the avoided cost. The small power producer pays for the equipment.

Purchase of Power Agreements:

YECL has not concluded a purchase of power agreement for a remote community. It is waiting for proposals to be submitted, but must ensure that its overall costs will not be increased.

NORTHERN CANADA POWER COMMISSION (NCPC)*

Policies and Parallel Generation:

Policies were established in 1986. NCPC will purchase power from small power producers on a case by case basis, as long as safety standards are met. Policies are the same for both small-hydro and wind.

Utility Procedures for Small Power Producers:

The small power producer must contact two departments: the N.W.T. Department of Energy (the project must be developed according to their standards) and the NCPC Operations Manager (he will inform the developer of the standards).

Energy Rates:

No precise rates are set. Each proposal is examined independently. Generally, the cost of buying from the small power producer will be weighed against the cost of the utility producing the energy. The rate paid for energy will vary according to costs such as fuel and transportation.

Metering:

The utility supplies, installs, and reads the meters every month or two. In order to save costs, every third month is estimated. Meters are located at the facility and a qualified electrician inspects the installation for wiring, etc. This cost is covered by the utility. The utility also pays for the meter, but partially reclaims this cost through a $5.00 per month service charge.

Purchase of Power Agreements:

A purchase of power agreement has been concluded at Cambridge Bay with Norwester Energy Systems Limited. This installation consists of four, 25 kW turbines. The small power producer will retain ownership for the first two years, and will be paid at a rate of $0.151/kWh. The ownership will then be transferred to NCPC.

NCPC is not looking for small power producers because they believe these installations do not improve the reliability of their own systems.

** NCPC is currently being transferred to the Governments of the Yukon and Northwest Territories.*

UTILITY CONTACTS

Ontario Hydro
700 University Avenue
Toronto, Ontario
M5G 1X6
(416) 592-4728

Newfoundland and Labrador Hydro (NLH)
P.O. Box 9100
St. John's, Newfoundland
A1A 2X8
(709) 737-1400

Hydro-Quebec
75 Boul. René-Lévesque Ouest
Montreal, Quebec
H2Z 1A4
(514) 289-3781

B.C. Hydro
970 Burrard Street
Vancouver, British Columbia
V6Z 1Y3
(604) 663-2223

Saskatchewan Power Corporation (SPC)
2025 Victoria Avenue
Regina, Saskatchewan
S4P 0S1
(306) 566-2121

Manitoba Hydro
820 Taylor Avenue
P.O. Box 815
Winnipeg, Manitoba
R3C 2P4
(204) 474-3311

Alberta Power Limited
10035 105th Street
Edmonton, Alberta
T5J 2V6
(403) 420-7627

Yukon Electrical Company Limited (YECL)
P.O. Box 4190
Whitehorse, Yukon
Y1A 3T4
(403) 667-2494

Northern Canada Power Commission (NCPC)
7909 51st Avenue
Edmonton, Alberta
T6E 5L9
(403) 465-3377

APPENDIX B

LIST OF MANUFACTURERS

APPENDIX B: LIST OF MANUFACTURERS

SMALL HYDRO MANUFACTURERS

CANADIAN EQUIPMENT MANUFACTURERS

Firm	Type of Equipment
ABCO Plastics Limited P.O. Box 299 MAHONE BAY, Nova Scotia B0J 2E0	Penstocks Fiber Reinforced Pipe and Fittings
Allis-Chalmers Canada Inc. 125 St. Joseph Blvd LACHINE, Quebec H8S 2L2	Turbines: Propeller (50 kW to 5,000 kW)
Armco Westeel Inc. P.O. Box 313 MOUNT PEARL, Newfoundland A1N 2C3	Penstocks Corrugated Metal Pipe Water Control Gates
Barber Hydraulic Turbine P.O. Box 340 Barber Drive PORT COLBORNE, Ontario L3K 5W1	Turbines: Francis, Kaplan, Pelton Propeller (100 kW to 15,000 kW) Generators: Parallel Gear, Right Angle Gear, Belt Drive
Canadian General Electric Ontario Electric Utility Sales Division 1400 Castlefield Avenue TORONTO, Ontario M6B 4C4	Turbines: Francis, Kaplan, Pelton, (250 kW to 25,000 kW) Generators: Parallel Gear, Right Angle Gear, Epicyclic Gear
Canbar Inc. Box 280 WATERLOO, Ontario N2J 4A7	Penstocks: Wood stave (diameter 60 cm to 550 cm; pressure to 121 m head; length 30 m plus)
Dependable Turbine Ltd. Unit 78 3005 Murray Street PORT MOODIE, B.C. V3H 1X3	Turbines: Francis, Kaplan, Pelton, Turgo (5 kW to 3 MW)

B: List of Manufacturers

D.F.D. Steel Industries Ltd. 1694 Evangeline Road LONDON, Ontario N5W 3G7	Penstocks: Metal (diameter 20 cm to 400 cm; length 1.5 m plus)
Dominion Bridge Sulzer Inc. 555 Notre Dame Street LACHINE, Quebec H8S 4E7	Turbines: Kaplan, Propeller, Francis, Tube-Type (1,000 kW to 10,000 kW) "turnkey" installations supplied
Du Pont Canada Inc. Pipe Division P.O. Box 2200, Streetsville MISSISSAUGA, Ontario L5M 2H3	Polyethylene Pipe and Fittings
Ecolaire Canada Ltd. 41 Ardelt Place MOUNT PEARL, Newfoundland A1N 2C3	Trash Racks, Stoplogs, Radial Roller penstocks Water Control Gates
Electric Power Equipment 1285 Homer Street VANCOUVER, B.C. V6B 2Z2	Turbines and Packages
Energy Systems and Design Box 1557 SUSSEX, New Brunswick E0E 1P0	Turbines and Electical Systems Up to 2 kW (Residential)
Flygt Canada 300 Labrosse Avenue POINT CLAIRE, Quebec H9R 4V5	Turbines: Pelton (50 kW to 600 kW) Generators: Epicyclic Gear
Gult Steel (Nfld.) Ltd. P.O. Box 610 DEER LAKE, Newfoundland A0K 2E0	PVC Pipe and Fittings Corrugated Metal Pipe Aluminum Pipe Valves
Hayward Tyler 1 Vulcan Street REXDALE, Ontario M9W 1L3	Turbines: Pelton, Reverse Pump (10 kW to 5,000 kW)

Hodgsons Steel and Iron Works Ltd. 5580 Kalar Road NIAGARA FALLS, Ontario L2E 6S4	Penstocks: Metal (diameter 15 cm plus; length 1 m plus)
Howden Galt Inc. 73 Water Street North Cambridge Place, Unit 502 P.O. Box 1354 CAMBRIDGE, Ontario N1R 7G6	Turbines: Francis, Kaplan, Galt Design (20 kW plus), "turnkey" installations supplied
Hydrolec North America Inc. 925 Leroy Somer Blvd. GRANBY, Quebec J2G 8E2	Turbines: Kaplan, Pelton (5 kW to 500 kW) Generators: Parallel Gear, Epicyclic Gear
Hymac Machine Shop 100 Barrick Road PORT COLBOURNE, Ontario L3K 5S5	Turbines and Packages
Ingersoll-Rand Canada 255 Lesmill Road TORONTO, Ontario M3B 2V1	Turbines: Francis (50 kW to 20 MW)
Kato Engineering (Finning Power Products) 555 Great Northern Way VANCOUVER, B.C. V5T 1E2	Generators
CP Kock Ltd. 8932 Oak Street VANCOUVER, B.C. V6P 4B7	Turbines
Leroy Somer Canada Ltd. 925 Leroy Somer Blvd. GRANBY, Quebec J2J 1E9	Turbines: Kaplan, Pelton (5 kW to 500 kW) Generators: Parallel Gear, Epicyclic Gear
McKay Water Power Ltd. P.O. Box 488 PORT COLBORNE, Ontario L3K 5X7	Turbines: Fixed Stayvane (2 kW to 1,000 kW)

B: List of Manufacturers

Nova Energy Limited 40 Wright Avenue DARTMOUTH, Nova Scotia B3B 1G6	Turbines: Propeller (5 kW to 1,000 kW)
Ossberger Turbines (Gordon Russel Ltd.) 7600 Alderbridge Way RICHMOND, B.C. V6X 2A2	Turbines and Packages
Reliance Electric Ltd. 678 Erie Street STRATFORD, Ontario N5A 6W1	Generators: Parallel Gear, Right Angle Gear, Epicyclic Gear Belt Drive, Rim Type
Schlenker Industries 2795 Third Avenue East Box 908 OWEN SOUND, Ontario N4K 2M5	Generators
Simpson Power Products 5271 Regent St. BURNABY, B.C. V5C 4H4	Generators
Simson-Maxwell Ltd. 1380 - 6th Avenue VANCOUVER, B.C. V6H 1A7	Generators
Sleegers Machining & Fabricating Inc. 649-3rd Street LONDON, Ontario N5V 2C1	Penstocks: Metal (diameter 50 cm plus; length 1.5 m plus)
Solace Energy Centre Inc. 4025 Hastings Street East BURNABY, B.C. V5C 2J1	Turbines (New and Used): Cross Flow, Kaplan, Pelton (0.2 kW to 100 kW) Electronic Governors
Thomson and Howe Energy Systems Inc. Site 17, Box 2, SS1 KIMBERLEY, B.C. V1A 2Y3	Governors

Waterwheel Erectors Ltd.
P.O. Box 246
WELLAND, Ontario
L3B 5P4

Turbines:
Propeller (100 kW to 2,000 kW)
Turbine Repair -- all types/sizes

Westinghouse Canada Inc.
Box 510
HAMILTON, Ontario
L8N 3K2

Generators and Electrical Components

AMERICAN EQUIPMENT MANUFACTURERS

Canyon Industries Inc.
5346 Mosquito Lake Road
Deming, Washington
98244, USA

Turbines:
Pelton (5 kW to 5 MW)
Cross Flow (5 kW to 500 kW)

The James Leffel & Co.
P.O. Box 1607
Springfield, Ohio
45501, USA

Turbines:
Vertical Samson Turbine
(Francis)
(Up to 100 kW)

Natural Power Inc.
New Boston
New Hampshire
03070, USA

Governors

North American Turbine Co. Inc.
3140 W Warner Avenue
Santa Anna, California
93704, USA

Turbines and Packages

Woodward Governor Company
5001 N. 2nd Street
Rockford, Illinois
61101, USA

Mechanical Governors

B: List of Manufacturers

WIND POWER MANUFACTURERS

CANADIAN EQUIPMENT MANUFACTURERS

Adecon Energy Systems Inc. 32 Rivalda Road WESTON, Ontario M9M 2M3	Manufactures Darrieus vertical axis wind generators of 125 kW for grid connection and remote l wind-diesel. Manufactures a VAWT-125 kW mounted on an external frame support; rotor height is 17 m and rotor diameter is 11.5 m
Howden Group Canada Ltd. 1510 Birchmount Road SCARBOROUGH, Ontario M1P 2G6	Manufactures propeller type wind generators 60 kW and above for grid connection and remote wind-diesel. Produces 3 bladed VAWTs of 60 kW, 220 kW, 330 kW and 750 kW. The units are built mainly in Glasgow (U.K.) and in the U.S.A.
Canadian Agtechnology Partners Inc. Olds Professional Building 5037 50th Street OLDS, Alberta T0M 1P0	Manufactures multi-blade water pumps
C&D Batteries of Canada 150 Connie Crescent, Unit 15 CONCORD, Ontario L4K 1L9	Sells lead-acid (calcium) batteries for photovoltaic and power wind applications
DAF Indal Ltd. 3570 Hawkestone Road MISSISSAUGA, Ontario L5C 2V8	Manufactures Darrieus vertical axis wind generators of 50 kW and 500 kW for grid connection. Manufactures 11 meter and 24 meter diameter Darrieus VAWT featuring two aluminum blades. The 11 meter produces 50 kW and the 24 meter 500 kW
Flender Power Transmission Inc. 151 Nashdene Court, Unit 11 SCARBOROUGH, Ontario M1V 2T3	Manufactures helical and planetary gear units (55-850 kW)

Heli-o-Beauce 680 30ième Rue Ville St. Georges - Ouest BEAUCE, Quebec G0M 1E0	Manufactures 1 kW propeller type AC or DC wind generators
Marapat Wind Power Ltd. Box 197 STIRLING, Alberta T0K 2E0	Manufactures 12.5 kW - 32 kW horizontal axis wind turbines
Massey Enterprises P.O. Box 1299 FT. MCLEOD, Alberta T0L 0Z0	Developing two turbines. The design intended for production features a small hydraulic pump on the tower, which feeds pressurized fluid to a turbine at ground level for a variety of uses, including electricity generation. Several prototypes of the 3 bladed unit have been built with 4 m and 5 m diameter rotors. A 6 m diameter model is planned. The second design is a smaller machine suitable for water pumping
Merrit Windmills Inc. Box 1374 MERRIT, B.C. V0K 2P0	Manufactures 150 W and 1.5 kW vertical axis wind generators
Ontario Battery Services 50 Galaxy Blvd., Unit 10 REXDALE, Ontario M9W 4Y5	Distributor of Winco Wincharger 200 W and 450 W wind generators; sells deep discharge batteries and inverters for wind power applications

B: List of Manufacturers

Thermax Canada Ltd. Renewable Energy Products 39 Main Street VANKLEEK HILL, Ontario K0B 1R0	Manufactures 150 W vertical axis helius rotor kit and 200 W propeller type wind generator, low RPM generators, inverters, voltage regulators, towers. Thermax is also a manufacturer of two very small wind generators, one horizontal axis and one vertical axis (The Helius rotor). The VAWT Helius is 1.5 meters tall and produces 25 W in 40 km/h wind speed. The new horizontal axis unit, called Windstream, generates 60 W in 40 km/h wind speed and 100 W in 48 km/h. It is 1 m in diameter
Victrix Limited 91 Duke Street P.O. Box 1807 GUELPH, Ontario N1H 7A1	Manufactures 20 kW vertical axis AC or DC wind generator
Wellington Wind Power Box 15 WELLINGTON, Ontario K0K 3L0	Manufacturers of small wind generators (600 W, 1kW, 1.5kW, 3 kW, 5 kW, 7kW and 10 kW) designed as DC generators for remote site power supply but rebuilt as horizontal axis, upwind turbines.
Wind Dynamics Wind Power Supply Co. 208 Stockton Avenue OKOTOKS, Alberta T0L 1T0	Manufactures 3.7 m diameter water pumps and distributes Enertech 1.5W, 25 kW and 40 kW AC wind generators. Manufactures water pumping windmills, holds a manufacturing licence for the Wilkes Cam design. The company is also a distributor of Enertech wind generators, designed for utility interfaced HAWT from 1 kW to 10 kW.
Wind Turbine Company of Canada Ltd. 21 Howard Avenue ELMIRA, Ontario N3B 2C9	Manufactures and erects Trylan lattice, self-support towers and water pumps.

AMERICAN EQUIPMENT MANUFACTURERS

Aerolite Inc. P.O. Box 576 South Dartmouth, Massachusetts 02748	Manufactures 6 kW and 10 kW propeller type, grid connected wind generators
Air Track Marketing Inc. Three Bridges Road P.O. Box 1080 Federalsburg, Maryland 21632	Manufactures 3 kW propeller type DC and grid connected wind generators
Bergey Windpower 2001 Priestly Avenue Norman, Oklahoma 73069	Manufactures 1 kW and 10 kW propeller type DC or AC wind generators
Best Energy Systems for Tomorrow Inc. P.O. Box 280 Necedah, Wisconsin 54646	Manufactures stand-alone inverters, 600 W to 12 kW
Bowjon 2829 Burton Avenue Burbank, California 91504	Manufactures wind powered, air lift water pumps
Elfin Company 550 Chippenhook Road Wallingford, Vermont 05773	Manufactures 7.5 kW propeller type, AC or DC wind generators
Hummingbird Windpower Corporation Rip Van Winkle 12306 Houston, Texas 77024	Manufactures 4 kW propeller type, DC or grid connected wind generators
Jacobs Wind Electric Co. 2720 Fernbrook Lane Minneapolis, Minnesota 55441	Manufactures 10 kW to 18 kW propellor type, AC wind generators
Jay Carter Enterprise P.O. Box 684 Burkburnett, Texas 76354	Manufactures 25 kW propeller type, grid connected wind generators

B: List of Manufacturers

Millville Windmills Inc. 10335 Old 44 Drive Millville, California 96062	Manufactures 10 kW propeller type, grid connected wind generators
North Wind Power Company Box 556 Moretown, Vermont 05660	Manufactures 2 kW and 180 kW propeller type, DC wind generators
PM Windpower Inc. P.O. Box 89 Mentor, Oklahoma 44060	Manufactures 25 kW propeller type, grid connected wind generators
Product Development Institute 1740 Eben Road North Holland, Ohio 43528	Manufactures 6 kW propeller type, grid connected wind generator
Sencenbaugh Wind Electric P.O. Box 1174 Palo Alto, California 94306	Manufactures 500 W to 1 kW propeller type, DC wind generators
Solargy Corporation 17914 E. Warren Avenue Detroit, Michigan 48224	Manufactures lattice and monotube, free-standing and guyed towers
Unarco-Rohn P.O. Box 2000 Peoria, Illinois 61656	Manufactures guyed and free-standing towers
Whirlwind Power Co. 207 1/2 E. Superior Street Duluth, Minnesota 55802	Manufactures 3 kW DC or grid connected wind generators
Winco c/o Dyna Technology 7850 Metro Parkway Minneapolis, Minnesota 55420	Manufactures 200 W and 450 kW propeller type, DC wind generators

Wind Power Systems Inc. 8630 Production Avenue, Building A San Diego, California 92121	Manufactures 25 kW to 60 kW propeller type, DC or AC wind generators
Windtech Inc. P.O. Box 837 Glastonbury, Connecticut 06033	Manufactures 20 kW to 75 kW propeller type, grid connected wind generators
Windworks Route 3, Box 44A Mukwonago, Wisconsin 53149	Manufactures 10 kW propeller type, AC or DC wind generators, sells synchronous inverters
Winpower Corporation 1207 First Avenue East Newton, Iowa 50208	Manufactures a 3 kW grid connected wind generator

Equipment is also available from European manufacturers. For further information, please contact the Canadian Wind Energy Association (See Appendix G).

APPENDIX C

REFERENCE PUBLICATIONS

APPENDIX C: REFERENCE PUBLICATIONS

Small Hydropower Handbook for British Columbia

Energy, Mines and Resources Canada
Conservation and Renewable Energy Office, British Columbia
March 1986.

Small Hydropower Handbook for Newfoundland and Labrador

Energy Mines and Resources Canada
Conservation and Renewable Energy Office, Newfoundland
September 1987

Small Hydropower Legislation in Ontario: A Guide to the Approval Process

Ontario Ministry of Energy
56 Wellesley St. West
Toronto, Ontario
M7A 2B7

Streams of Power - Developing Small Scale Hydro Systems

Ontario Ministry of Energy
Published by Renewable Energy in Canada Ltd., (1986)
334 King Street East, #208,
Toronto, Ontario
M5A 1K8

Integration of Wind Turbine Generators Into Small Diesel-Based Power Systems

Canadian Electrical Association
Prepared by ERA Technology Ltd.
Cleeve Road, Leatherhead, Surrey England
December 1985

Utility Policies Towards Customer Owned Generating Facilities

Canadian Electrical Association
Prepared by Cogeneration Associates Ltd. - Alex Juchymenko
October 1985

Utility Policy on Co-Generation and Small Power Production

Canadian Electrical Association
Prepared by Transalta Utilities Corporation
H.D. Miller, W.D. Gibson
Calgary, Alberta
October 1984

The Remote Community Demonstration Program of Energy, Mines and Resources Canada has funded studies on wind and small-hydro to which the interested person should refer.

APPENDIX D

GOVERNMENT APPROVALS PROCESS

This appendix should be used in conjunction with Appendix A, Utility Policies, Rates and Service Conditions.

APPENDIX D: GOVERNMENT APPROVALS PROCESS

INTRODUCTION

This appendix provides an overview of the government agencies that interact with remote, independent power developers during the project approvals process. Information is also included on when and how this interaction takes place. Much of the information focusses on small-hydro projects which, because of their broader effect on the environment, require a more complex approvals process.

The information provided is general in nature. It is suggested that developers contact the appropriate agency/department in the province of their location early to ensure they have a sufficient understanding of the detailed approval requirements, are dealing with the appropriate offices and individuals, and are working with the most up-to-date material.

In this appendix federal government approvals procedures are reviewed first, followed by a summary of corresponding requirements for each province, and then by a list of agencies/departments by province.

D: Government Approvals Process

FEDERAL GOVERNMENT

If an independent power project receives federal funding or involves federal land or is otherwise suggested by the federal government, then it must fulfill the requirements of the federal Environmental Assessment and Review Process (EARP).

EARP consists of two phases. In the screening phase, the federal agency/department responsible for the project must review the proposal for possible, undesirable environmental impacts. If none are identified, then the developer may proceed provided that other requirements of the approvals process are satisfied. If the screening phase determines that the project may have some undesirable effects on the environment, or is the subject of significant public concern, then the proposal is sent to the Minister of Environment who refers it to the federal Environmental Assessment Review Office for formal public hearings.

If the effects of the project are not clear, the agency/department may request that the developer carry out an Initial Environmental Evaluation (IEE). The IEE must contain a description of the project and an evaluation of possible alternatives including a description of the environmental setting and the forseeable impacts. If the agency/department decides that there are significant undesirable impacts, or more information is needed, then a formal review is required.

Where public hearings are required, an independent panel is formed. The panel determines the issues to be addressed during the hearing. These issues are addressed in an Environmental Impact Statement (EIS) which describes the project, the existing environment, and the possible impact the project may have on the environment. The EIS provides a basis for discussion at public environmental hearings.

The panel makes its recommendations to the federal Minister of the Environment and to the Minister of the initiating department. Final decision rests with the Ministers and Cabinet.

If the water course proposed for the small-hydro development is navigable, then the developer must apply to Transport Canada for approval of construction under the Navigable Waters Protection Act. New dams, modifications to existing dams, and the intake of the turbine for small-hydro projects are subject to the Canadian Fisheries Act, usually administered by the provincial agency responsible for natural resources.

Under the Beds of Navigable Waters Act, the beds of all navigable waters belong to the Crown, unless expressly given to an individual in the original letters patent. If the bed is Crown owned, then the developer must apply to the provincial ministry responsible for granting a water power lease.

NEWFOUNDLAND

The first step in the approvals process for a small-hydro installation is the submission of a brief outline of the proposed project to the provincial Department of the Environment. The developer must also complete a series of forms which relate to project requirements and impacts. The provincial Department of the Environment must reply within 45 days of receiving the submission. During this time, the proposal is sent to all Ministries and departments which would be affected by the installation. The Department of the Environment decides which of the federal agencies must be contacted, depending on the potential impact of the project. Provincial departments which may be contacted include the Departments of Energy, Forestry, Transportation, Wildlife, and Land.

Additional approvals must come from the City of St. John's (building permits), and the Department of Labour and Manpower (approval of electrical equipment). The developer should also contact the municipal offices for the remote community early in the project study.

Comments on the proposed project are sent to the developer. He may be required to supply additional information, depending upon the potential impact of the installation.

The developer deals primarily with the province. The approvals process in Newfoundland is very rigorous, and therefore projects that are approved at the provincial level of government will probably be approved at the federal level of government.

The approvals process for wind installations is the same as for small-hydro installations; however, the process is less involved because the perceived impact is less.

D: Government Approvals Process

SASKATCHEWAN

A developer wishing to develop a small-hydro or wind power installation must first send an outline of the project to the Saskatchewan Environmental Assessment Branch. The submission will be reviewed and sent out to all relevant agencies for their comments. These agencies include the Director of Public Safety, and the Saskatchewan Power Corporation. If the installation is to be on federal land, then the federal approvals process must take place.

The local municipality would eventually issue the building permit, and Saskatchewan Environmental and Public Safety would approve the electrical equipment.

Once the project plan has been examined by all relevant agencies, it is sent back to the developer with remarks and suggestions for any additional information which may be required.

After all approvals are in place and the review process has been completed, the developer must apply for a license for approval of construction. For small-hydro projects, application is made to Transport Canada in Vancouver, British Columbia. This condition only applies to navigable streams, to ensure that the installation does not interfere with local navigation.

QUEBEC

In Quebec, a developer with a proposed small-hydro installation project may need to send a summary of the project to two Provincial agencies; the Department of Energy and Resources, and the Department of the Environment (Environnement Quebec). The Department of Energy and Resources reviews the proposal and makes recommendations to Hydro-Quebec.

Federal agencies usually do not need to be contacted for small installations in Quebec. For those that are simple and use existing dams, the developer need only contact the Department of Energy and Resources. If the installation is large, and new, various federal agencies need to be involved. This is coordinated through the Department of the Environment.

If the property is on federal lands, then the Crown Lands Act is involved. The developer must apply to lease the land through the Department of Energy and Resources. A rate will be determined in accordance with the Quebec Waters Act.

Installations which are being proposed, which would be for the developer's own needs, do not require approval of electrical equipment. If the installation is to service Hydro-Quebec and connect to their grid, then the developer must obtain a permit from Hydro-Quebec which deals with the preparation of contracts outlining power, equipment, meters, and safety measures.

Wind power installations usually do not require any approval. Wind installations where there may be a problem with height or visual impact, for example a wind farm; or, installations which will be connected to the Hydro-Quebec grid are an exception. In these instances, the approval process is similar to that for small-hydro.

D: Government Approvals Process

MANITOBA

In Manitoba, a developer with a proposal for a small-hydro installation must send a written outline describing the project to the provincial Water Resources Branch. The proposal will be circulated to other related government departments. These government departments include: Water Rights and Licence, the Department of the Environment, Workplace and Safety, Conservation District Act (this applies in the southern part of the province where agricultural areas exist), and the Department of Labour (for electrical approvals). Once their comments have been submitted, the Water Resources Branch informs the developer of any additional information required before the project can receive final approval. The Water Resources Branch would be involved in the federal Environment Assessment and Review Process, if federal money were to be involved.

Wind installations are affected only by municipal requirements, so a developer simply needs to contact the relevant municipality and obtain a building permit.

ONTARIO

In Ontario, several provincial and federal statutory approvals regulate the private development of small-hydro sites. Though the approval process is seemingly complicated, both the Government of Ontario and the provincial utility, Ontario Hydro, encourage private, small-hydro development and attempts have been made to streamline the approval process.

The first step is fulfilling the requirements of the Ontario Lakes and River Improvement Act. This Act regulates the development of water power sites in Ontario and is administered by the local district office of the Ontario Ministry of Natural Resources (MNR). Two levels of approval are required under this Act. First, location approval sanctions the concept of small hydro at a proposed site, and, secondly, approval of plans and specifications sanctions the engineering and construction specifications of a proposed project. The MNR's district office provides both levels of approval and will outline the type of information required. If significant environmental impact is anticipated, then the project may be referred to the Ministry of the Environment for consideration under the Environmental Assessment Act.

Other provincial approvals that will be needed include: a water taking permit required by the Ontario Water Resources Act; a water power lease under the Public Lands Act; approvals under the electrical safety codes; and a number of secondary approvals related to building, zoning and construction.

If the proposed project is located on a navigable waterway, then an approval under the Navigable Waters Protection Act is required. If the project is located on federally owned land or is funded by a federal agency, then the federal Environmental Assessment and Review Process must be followed. Small hydro projects located on federal land or waterways must also be approved under the Dominion Water Power Act.

D: Government Approvals Process

YUKON

In the Yukon, a developer must submit a brief outline of his proposed project to the Regional Environmental Review Committee (RERC). Other government bodies are also involved in reviewing the proposal, such as Fisheries and Oceans Canada. If the developer's proposal is approved, the developer must then apply to the Water Board, which was created by the Northern Inland Waters Act, to obtain water rights. The developer must also apply to the Department of Indian and Northern Affairs to obtain the land rights for the project.

Building permits and electrical approvals are obtained through the Yukon territorial government.

At present, no approvals process has been developed for wind power installations.

BRITISH COLUMBIA

The developer of a new, small-hydro installation should first contact the Water Rights Section of the Ministry of Environment. This office is able to issue a water licence, and determines which additional agencies need to be contacted and which permits obtained. These agencies may include: Land Titles Registry Office, British Columbia Utilities Commission, Ministry of Labour, Electrical Safety Branch, Insurance Agents, Municipal and Regional District Offices, Ministry of Lands, Parks and Housing, Ministry of Forests, and Ministry of Highways. Federal agencies may include: Indian and Northern Affairs Canada, Parks Canada, Fisheries and Oceans Canada, and Transport Canada.

The Water Branch sends the application forms from the relevant agencies to the developer. The developer then completes these forms and fulfills any necessary requirements.

There is no review process yet for wind power installations, since there have not been any applications to British Columbia.

D: Government Approvals Process

NORTHWEST TERRITORIES

Developers with proposals for small-hydro installations will be given advice on how to proceed and who to contact after making initial contact with the Environment and Conservation Division of the Renewable Resources and Energy Board, Indian and Northern Affairs Canada (INAC).

After the proposal is screened to ensure that it fulfills the criteria set out by INAC, it is then sent to a division of INAC (Northern Development) which controls the activities of the developers according to certain requirements such as land and water use.

The next step for the developer is to request a water licence from the Water Board, after review by both the Technical Advisory Committee and the Environmental Advisory Committee (which are part of the Water Board). Federal agencies must also be contacted at this time, and can include Transport Canada, Fisheries and Oceans Canada, and the Territorial Lands Act.

ALBERTA

The developer of either small-hydro or wind power installations in Alberta must seek approvals mainly from the provincial levels of government. The federal Environmental Assessment and Review Process (EARP) is involved only if federal lands are affected and/or if the proposed facility is inter-provincial. Other federal agencies would only become involved if they were directly affected by the power project.

In Alberta, the proponent must submit letters outlining the proposed project to both the Energy Resource Conservation Board (ERCB) and the Alberta Environment. The ERCB regulates all energy related matters in Alberta (coal, oil, etc.), and is responsible for the approval of the physical aspects of the facility, such as dams and transmission lines. This would involve the Electrical Act and the Energy Act. The ERCB is responsible, in part, for the environmental assessment and for guiding the proponent through the approval process.

The proponent must also apply to the Alberta Environment in order to obtain a Water Use Permit. The Alberta Environment is also partially responsible for the environmental assessment. Both the ERCB and the Alberta Environment coordinate their efforts in order to work more effectively in the approval of developers' project proposals.

Building permits must be approved by the municipality in the area where the project is being constructed. Approval of electrical equipment is issued by the Electrical Protection Branch of the Department of Labour.

The approval process is the same for wind and hydro, although the process for wind could possibly involve fewer government approvals because the perceived impacts are less. If the generating installation is for the sole use of the developer, the approvals process is not required. The developer only needs approval when the facility is connected to the provincial grid.

D: Government Approvals Process

GOVERNMENT CONTACTS

Newfoundland:
Department of the Environment
(709) 576-3538

Quebec:
Environnement Quebec
(418) 643-2006

Ontario:
Ministry of Natural Resources
Land Management Branch, Public Lands Section,
(416) 965-4507

Manitoba:
Water Resources Branch
(204) 975-6398

Saskatchewan:
Saskatchewan Environmental Assessment Branch
(306) 787-6171

Alberta:
Energy Resource Conservation Board
(403) 297-8344

British Columbia:
The British Columbia Water Branch
(604) 387-1154

Northwest Territories:
Environmental Assessment Board
(403) 920-8240

Yukon:
Regional Environmental Review Committee
(403) 667-3172

Federal Government:
Federal Environmental Assessment Review Office
(819) 997-1000

APPENDIX E

TECHNICAL OVERVIEW OF SYSTEMS

APPENDIX E: TECHNICAL OVERVIEW OF SYSTEMS

SMALL-HYDRO INSTALLATION: GENERIC DESCRIPTION

All small-hydro installations are intended to generate either mechanical or electrical power. They start with a steadily flowing stream or river, and use the energy available in falling water to turn a mechanical device. This mechanical device either turns other mechanical devices, or produces electricity by turning the shaft of a generator. Small-hydro installations can generally be broken down into the following components:

- headworks and trashrack;
- penstock;
- powerhouse
- turbine, electrical generator and switch gear;
- draft tube and tailrace;
- interconnection to grid.

Headworks and Trashrack

These consist of a method (dam or weir) to collect or impound water (the headpond) and clear the water of debris (trashrack) as it is delivered to the penstock. The method of impounding water and the effectiveness of the trashrack in clearing the water of debris is particularly crucial to the success of a remote power installation because of accessibility problems and the requirement to keep maintenance costs low. In some cases, it may be necessary to build a dam or weir to impound water. In others, it may be necessary only to locate an intake pipe several feet below the low water mark of a river. In either case, it is necessary to provide a trashrack design which can be easily kept free of debris such as leaves in the fall, or the buildup of ice in the water.

Penstock

This is a pipe which conveys the water from the intake to the powerhouse and turbine. It can be made of wood, plastic, fiberglass, or metal, and must be securely anchored along its whole length. Accessibility and transportation costs may make the installer of a remote small hydro system think carefully about the selection of material for the penstock.

Powerhouse

This is the building or container that houses the turbine and electrical or other mechanical equipment. Frequently it is built on a concrete foundation, but experience has proven that it can be built of concrete blocks, or of wood frame or log construction. This depends on the size of the installation, its location, and the pressures that the powerhouse and penstock come under. One innovative, remote power system uses a waterproof, steel container anchored to a concrete pad to house the turbine and electrical equipment.

Turbine, Electrical Generator, and Switch Gear

The turbine converts the energy available in the falling water to mechanical energy by rotation of its shaft. The turbine drives the shaft of an electrical generator through a speed increaser. The electrical output of the generator is then conditioned to meet the voltage and frequency specifications of the load.

The characteristics of the turbine and generator in a remote installation are critical to the success of the system. The turbine must be carefully matched to the head and flow characteristics of the stream or river supplying water to it. The generator and its controls must also be carefully chosen to match the characteristics of the load. One of the major design considerations is the selection of either a synchronous or an induction generator. The synchronous generator is capable of operating independently of the diesel grid. The induction generator references the diesel grid to maintain the frequency and voltage output of the system such that if the diesel grid fails, so does the independent installation.

Draft Tube and Tailrace

These components deliver the water from the turbine, back to the stream or river from which it was taken.

Interconnection to Community Grid

Interconnection to the community diesel grid is made through a small sub-station. The sub-station consists of a transformer, switches and safety devices, and metering equipment which measures the electrical output of the system. The means of disconnecting the two systems is crucial because of safety considerations. In the event of a power outage, technicians must be able to repair the existing grid without fear of electrocution through backfeeding into the grid from the independent power system. This is particularly important in remote communities because of the need for frequent maintenance and repair of the diesel generating facilities and the community distribution system.

Siting

Siting of a remote power system is crucial to the economics of the system. Because of the high cost of transmission, the closer the site is to the community, the better. The site should generally be within about ten kilometers of the community.

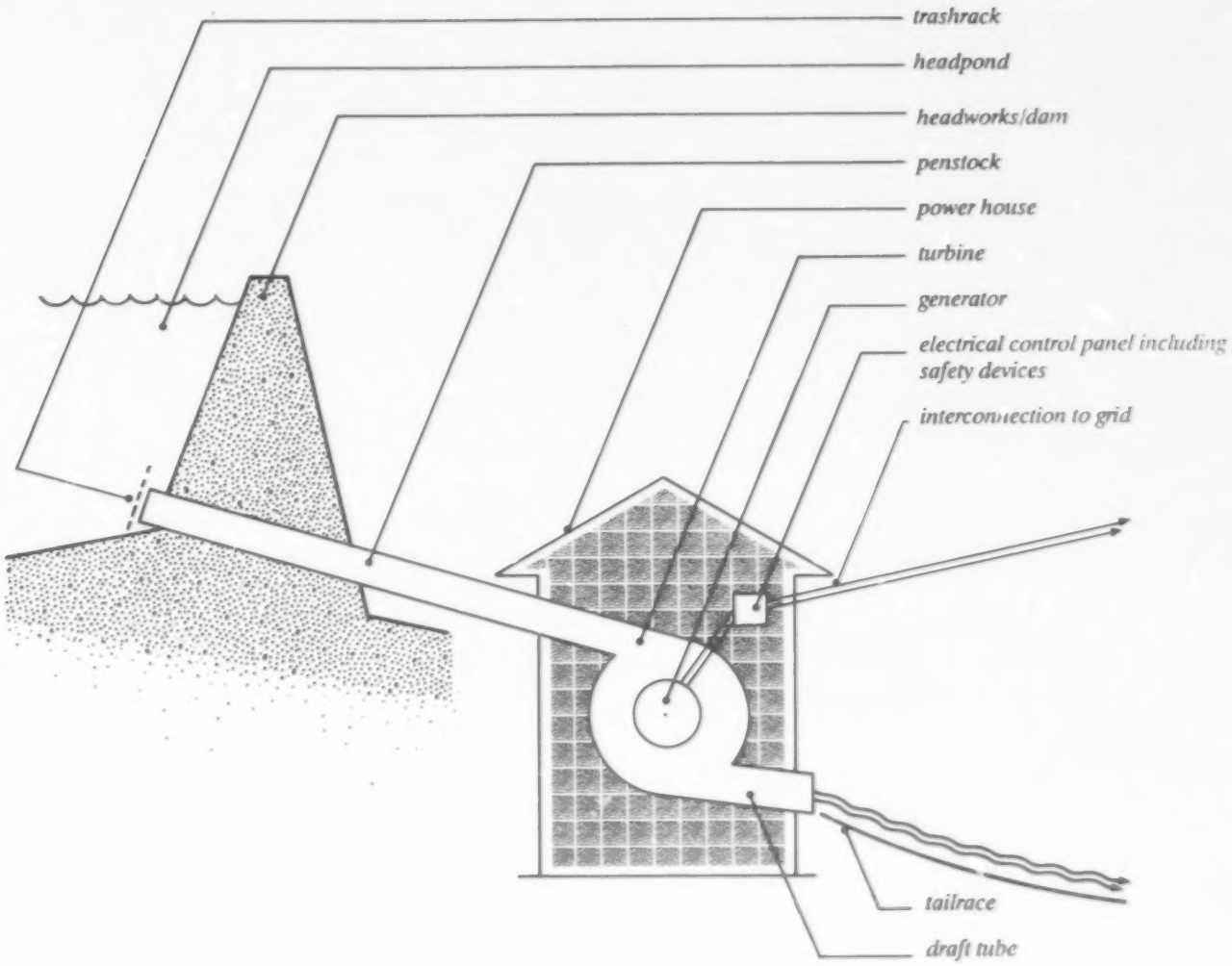
Sizing

Sizing of a small-hydro unit is most often limited by the characteristics of a particular site, that is the head and flow at the site, and by the anticipated load. Load growth should be taken into account. The unit should be sized to accommodate the existing and anticipated community load.

SMALL WIND POWER INSTALLATION: GENERIC DESCRIPTION

All wind power installations are intended to convert the available wind in a location to mechanical or electrical power. They convert the energy available in the wind by means of blades attached to a rotating shaft connected to an electrical generator, or a mechanical device. They need relatively steady and high wind speeds.

EXHIBIT E.1
SCHEMATIC DIAGRAM OF SMALL HYDRO INSTALLATION



E: Technical Overview of Systems

There are two ways for the wind turbine's blades to capture energy from the wind; by drag, or by aerodynamic lift. Drag turbines tend to be self starting, slow, and capable of high torque. They are most often used for pumping or churning applications and are characterized by large blade surfaces. Lift turbines operate at blade speeds which are must faster than the speed of the wind. They produce high torque and power at high speeds and are usually more efficient electrical producers than drag turbines. Lift turbine blades are usually very slender and have a relatively small surface area.

Turbines are also classified by the axis of their rotation. Horizontal axis turbines have several blades attached to a hub like an airplane propeller, and these have to be directed towards the wind. Vertical axis turbines have blades attached to the top and bottom of a vertical shaft and can capture the wind from any direction without being aimed.

Siting

Siting of a wind turbine is an important part of the planning of a system. The system performance can be dramatically effected by trees, buildings and other obstructions to the free flow of the wind. In general, wind turbines should be sited well away from major obstacles such as buildings and trees. Special considerations must be taken into account when surrounding terrain is hilly or contains ridges, valleys or cliffs.

Sizing

The output of the generator is also an important factor to consider. The degree of penetration of the local diesel grid must be taken into account so as not to oversize the wind installation. In general, the penetration will be a small but significant portion of the rating of the diesel system. Penetration levels can be enhanced or increased by careful and creative design of operating controls and use of short term storage and load management strategy. It should also be noted that the unique conditions encountered in remote communities can limit the size of equipment.

Tower

Horizontal axis machines are mounted on a tower which is generally made from steel or timber and will usually be about 20-30 m in height. The tower supports the wind turbine, blades, hub and nacelle. Vertical axis machines may or may not be mounted on a tower. The rotating column of a vertical axis wind turbine may be thought of as its tower.

Turbine

The turbine blades and rotor convert the energy in the wind to rotational shaft power. Blades are usually made from wood or fibre-reinforced plastic. There are usually two or three blades.

Drive Train

The drive train of a wind installation consists of a gearbox, generator and brake. These components are attached to the rotating shaft of the turbine. The generator output may be direct current for small, stand alone systems employ-

ing batteries but is most often alternating current. In the case of small-hydro, the A.C. generator can be fully independent (synchronous) or can be an induction motor which references its output to that produced by the diesel generators.

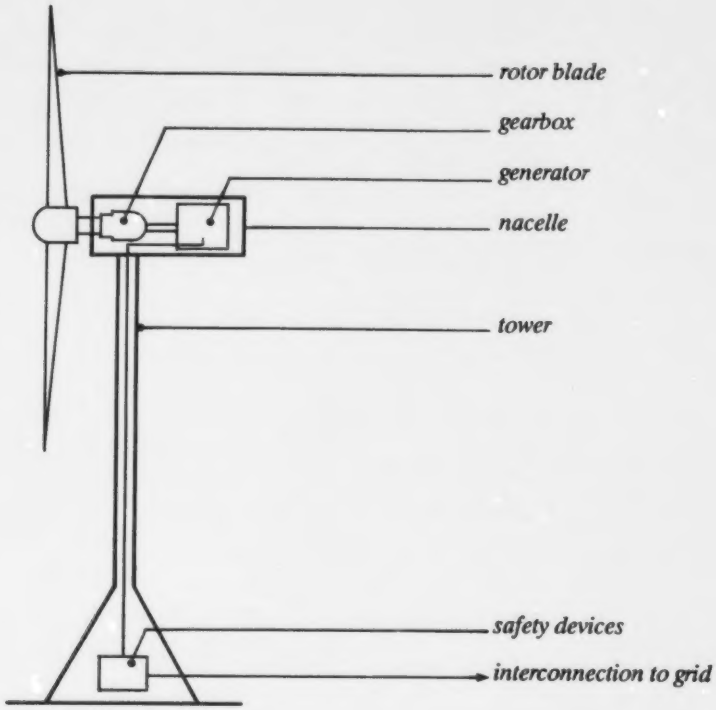
Interconnection to the Community Grid

This is accomplished through metering and protection devices in the same manner as for small-hydro systems. The quality and capabilities of these devices are equally important to the small power producer and the utility.

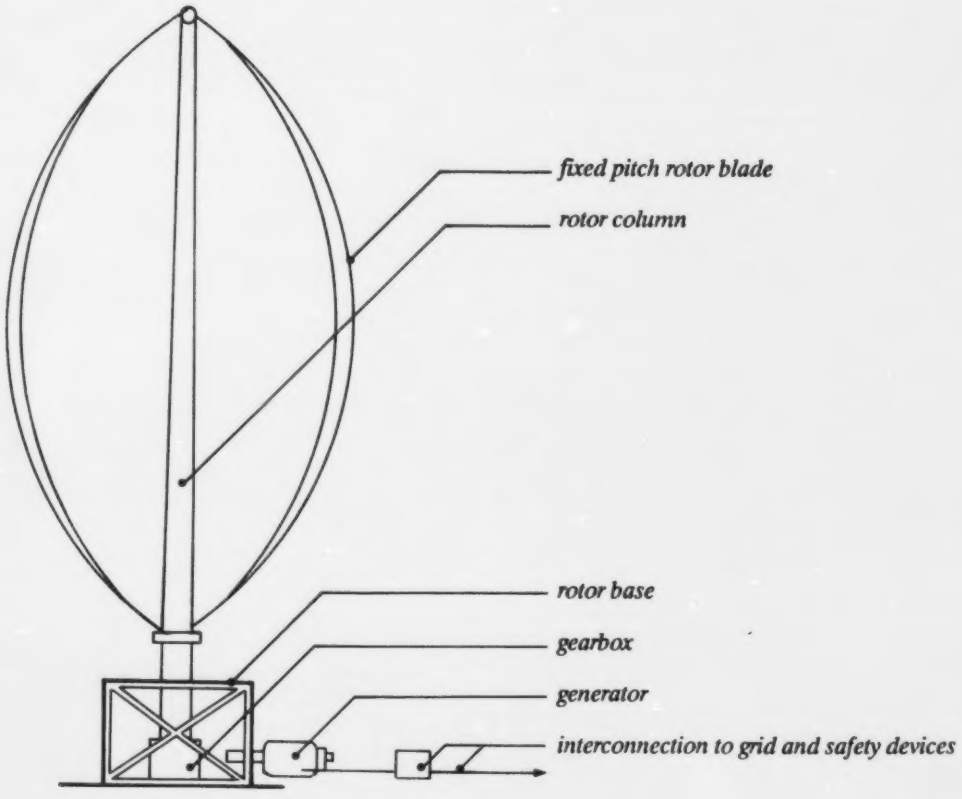
Technology Options

Experience has shown that a careful choice of technology is essential in the development of wind systems for remote communities. Harsh weather conditions, relative isolation, and a general lack of experience in operation and maintenance means that technology should be chosen for its high durability, reliability, accessibility of components and ease of maintenance. Many wind turbines and systems are available on the market today; however, very few of them have demonstrated reliability in remote, northern parts of Canada.

EXHIBIT E.2
SCHEMATIC DIAGRAMS OF WIND TURBINES



Horizontal Axis Wind Turbine (HAWT)



Vertical Axis Wind Turbine (VAWT)

APPENDIX F

CASE STUDIES

APPENDIX F: CASE STUDIES

SMALL-HYDRO INSTALLATION: MARY'S HARBOUR, LABRADOR

HISTORY AND TECHNICAL DESCRIPTION

In 1984, Newfoundland and Labrador Hydro (NLH), with support from Energy Mines and Resources Canada, completed a study which recommended the development of a small-hydro generating plant at Mary's Harbour. The next year, when the Newfoundland and Labrador Department of Municipal Affairs and Housing was installing a water supply system for the community, it made allowances to accommodate a hydroelectric installation as a result of a concept plan devised by an engineering firm.

The original study proposed a 300-500 kW plant requiring a budget of $3,000,000. This, however, was modified when the engineering firm which was doing the municipal water system became involved. The principals of this firm (Shepherd, Hedges and Green) revised the development plan and down-sized it to avoid the cost of a dam. Instead, the penstock was to be placed at the lower end of the municipal water system intake canal.

In June of 1986, a new concept proposal was submitted to Energy Mines and Resources, and in September of 1987 approval for the project was received. In the interim, the principals of Shepherd, Hedges and Green formed a development company called Mary's Harbour Hydro, and a series of discussions and negotiations among a variety of actors began.

The installation at Mary's Harbour consists of a .7 m diameter small kaplan turbine with manually adjustable blades driving a 175 kW, 600 volt, 1200 rpm synchronous generator via a single stage gearbox.

Water is supplied from an intake canal through a rectangular butterfly valve opened by a hydraulic cylinder and closed by a counterweight.

Station output is 135 kW at rated head and flow.

PROJECT MANAGEMENT CONSIDERATIONS

Regulations, Codes and Policies

Several barriers had to be overcome before the project could proceed. The first was that a change in legislation had to be made concerning the jurisdiction of NLH with respect to water rights. The utility requested that the provincial government remove the exclusive NLH jurisdiction over water rights for systems under one megawatt.

The second was that NLH requested that the provincial government exempt projects under one megawatt from regulatory hearings of the Public Utilities Board under the Public Utilities Act. These hearings could have increased project costs by up to 20%, and were viewed as unnecessary for this scale of project. Legislation is currently being proposed to permanently waive the hearings for small (under one megawatt), remote power projects. Approval for these types of projects may now be obtained through an exchange of letters between the Public Utilities Board and the utility.

The third was that the utility had to develop a set of procedures and policies with respect to parallel generation. Since the purchase of power from small power producers was a new concept for the utility, a series of meetings and discussions was held between the provincial government and the utility, Energy Mines and Resources and the utility, and the small power producer and the utility. Other provincial government departments involved included the Departments of Energy, Environment, and Municipal Affairs.

Approval had to be obtained at the local municipal level. When legal work was being carried out on the easements for transmission, it was determined that approval would also have to be obtained from the International Grenfell Mission land owners.

Cost Sharing Arrangements and Financial Considerations

Another major set of considerations revolved around the financing and economics of the project. Originally it was estimated at a $3,000,000 level. When it was downsized, the estimate was approximately $650,000. In order to obtain these funds, a variety of applications had to be made, and actors involved.

At the outset, it was determined that the major lending institutions would not finance the project, and venture capitalists required too high a proportion of equity (ownership) in the project to make it worthwhile to borrow private capital.

The Newfoundland Labrador Development Corporation was approached. Initially, they viewed the project as too risky, but they eventually provided funding on condition that other government funding was forthcoming from Energy Mines and Resources Canada and the Newfoundland Department of Energy. An additional requirement was for the proponent to put up 10% of the capital needed, and Shepherd, Hedges and Green did this. As a result of this experience, the provincial development corporation has been given a mandate to finance riskier projects than they had previously.

Another interesting fact is that the Corporation of Mary's Harbour is discussing the possibility of offering shares in its development to local residents by means of regular deposits made to a trust company branch which recently opened in the community. In this manner, local residents may become part owners of the installation and may benefit from the sale of power to the utility.

Division of Responsibility

The utility stated from the outset that they were not willing to incur any additional costs related to the installation. The small power producer had to pay for metering and the interconnection with the local community grid.

Technical Considerations

One interesting technical suggestion was made by the small power producer. The small power producer requested that the utility install a smaller diesel in the community in order that more of the load could be borne by the small-hydro unit. NLH agreed to this request, as they had a smaller diesel in stock. They have indicated that they will install the smaller diesel when it is convenient for them to do so. This technical adjustment improves the economic

return on the project and demonstrates the manner in which the small power producer and the utility can work productively together.

Logistical Considerations

All materials and equipment had to be shipped to the site via the CN coastal marine service. This placed an added load on the coastal service, and impacted on project scheduling.

Approvals and Contractual Considerations

All approvals were obtained without problems. The contract between Mary's Harbour Hydro and the utility is based upon a shared savings arrangement, with up to 90% of the savings going to the small power producer. Savings are determined by calculating the avoided cost of fuel and operation of the diesel plant, on a monthly basis. This allows for rapid adjustment of the rate and is to mutual advantage. It does, however, make the small power producer work with a low and a high scenario in his cash flow estimates. Rates for the power at Mary's Harbour are currently in the seven to eight cent a kilowatt-hour range.

TECHNICAL PROBLEMS ENCOUNTERED

Since the project has been commissioned, several minor problems have been encountered. These relate mainly to the water supply to the turbine. Excessive turbulence was encountered at the intake structure, and this had to be modified. Icing problems have also been encountered in the intake canal, due to unusual weather conditions. In addition to this, a problem with the computer controlled load governor was encountered which burned out several of the electrical dump load elements. This was traced to a faulty computer chip and the chip has been replaced.

ESTIMATED BENEFITS

Annual Energy output	800,000 kWh.
Utility Buy Back Rate	$0.072/kWh.
Annual Revenue	$57,600.00

FOUR UNIT WIND FARM: CAMBRIDGE BAY, NORTHWEST TERRITORIES

HISTORY AND TECHNICAL DESCRIPTION

In 1984, NCPC, NRCC, and EMR started discussing the desirability of a major wind energy demonstration in a remote Arctic community supplied with electricity from diesel generators and having a good wind energy resource. In 1986, a steering committee was formed and a preliminary project plan was developed. In early 1987, a specification and request for proposals to supply and install a 50-150 kW wind energy conversion system at Cambridge Bay in the Northwest Territories was developed, and a consultant was selected. A special feature of the project was the requirement that the equipment supplier retain fifty percent equity in the equipment for a period of two years after com-

missioning. In exchange for this equity, the supplier was to be paid $0.15 for each kWh generated by the wind turbine(s) during this period.

The successful respondent to the RFP was Nor'wester Energy Systems of Calgary, Alberta. They proposed to install four 25 kW Carter wind Turbines. A site was selected about three kilometers from Cambridge Bay along an existing transmission line.

The four machines were installed in September, 1987 and commenced operation shortly afterward. During the first week of operation, all four units failed due to a manufacturing error in assembling a modified generator with a longer rotor. The units were repaired and placed back in service in mid November. A few days later, the system distribution transformer failed when snow, driven by high winds, penetrated the enclosure and shorted the exposed windings of the air type transformer. An oil-filled replacement was ordered to replace the damaged unit and no further problems are anticipated.

This project was developed based on the premise that large scale application of wind energy for electrical generation in remote Arctic communities could best be achieved by the utility responsible for the supply of power. The rationale for this assumption was that the utility is often the only technically competent presence in the remote communities where wind energy might be feasible. Also, planning for future loads is a responsibility of the utility.

The Northern Canada Power Commission was involved in all phases of the planning and execution of this project and developed an effective management scheme for carrying out the demonstration and later operation of the project. The close cooperation and communication between the utility, the contractor, the consultant, and the EMR Remote Community Demonstration Program were essential to the success of the project.

PROJECT MANAGEMENT CONSIDERATIONS

Regulations, Codes and Policies

From the outset, the utility made it clear that all equipment supplied had to meet CSA standards. It was also made clear that power quality would have to meet the utility standard, and that the equipment and civil work would have to function reliably in arctic conditions.

Regulations specified that land use and construction permits would have to be obtained, along with approval from the Department of Transport (for height restrictions). All were duly obtained. Another major concern was community approval. The appropriateness of the demonstration as well as its planning and location would have to be discussed and approved. The community was approached through the settlement council, and approval was obtained.

Cost Sharing Arrangements and Financial Considerations

The project could only be realized with a contribution from the federal government. NCPC committed time and effort in terms of operation, maintenance, and administration. Financial arrangements with the installer have been discussed in the project history section.

Division of Responsibilities

No problems were encountered in this area. The utility obtained all necessary permits, and the small power producer provided a turnkey installation.

Technical Considerations

The small power producer was told to provide an "Arctic Package" for the equipment, and the request for proposals specified that the turbines had to be maintained with two men and a half-ton truck or light vehicle. Foundation requirements were also carefully specified for permafrost conditions.

Contractual Considerations

The contract signed between NCPC and the small power producer is the standard boiler plate NCPC contract dealing with subcontractors. The payment for energy is $.15/kWh and is based on the incremental cost of fuel oil.

The utility negotiated a five year extended warranty on the installation in order to determine the system's long-term performance without taking any risk.

Technical Problems Encountered

The manufacturer originally supplied 25 kW alternators with each turbine. Problems were encountered with all four alternator bearings and the alternators were re-designed and replaced with 35 kW models.

There was also a problem with the transformer. NCPC advised the manufacturer concerning the type of transformer to include in the package. However, the manufacturer did not follow the advice, and provided an air transformer not suited to Arctic conditions. Blowing snow entered the transformer and shorted it out. The manufacturer has now replaced this with an oil transformer and no further problems are anticipated.

ESTIMATED BENEFITS

Annual Energy Output	184,000 kWh
Utility Buy Back Rate	$0.151 /kWh
Annual Revenue	$27,784.

TWO UNIT WIND INSTALLATION: HALL BEACH, NORTHWEST TERRITORIES

HISTORY AND TECHNICAL DESCRIPTION

Recognizing that electrical energy costs for their nursing stations in remote Arctic communities were very high, Health and Welfare Canada's Health Services Branch (HWCHSB) carried out a wind energy feasibility study and wind data analysis. The study and analysis looked at four communities: Resolute Bay, Frobisher Bay (Iqaluit), Igloolik and Hall Beach. In 1981, Hall Beach was chosen because it had the most desirable wind regime, ease of access and interest by nursing station personnel. The assessment program was supported by the Energy, Mines and Resources Canada (EMR) Enerdemo Program. A committee of representatives from National Research Council of Canada

(NRCC), Energy, Mines and Resources Canada (EMR), Department of Supply and Services Canada (DSS) and HWCHSB was formed in 1983 to provide advice on technical matters.

In 1983, HWCHSB purchased a Northwind 9 kW L19 grid interface machine and had it installed at the Atlantic Wind Test Site to evaluate performance, correct any deficiencies and confirm reliability prior to installation at Hall Beach. The machine proved unreliable and underwent several significant design modifications. In 1986, while being lowered for Northwind field engineers to make adjustments, the lifting cable, which had become badly corroded, parted and the machine was destroyed.

In 1986, the project was restarted with support from the EMR RCDP program. A request for proposals (RFP) for supply and installation of a Wind Energy Conversion System (WECS) was issued. Aerowatt International (AWI) of Cedex, France was the successful respondent. In September 1987, two AWI 10 kW WECS were installed at the Hall Beach Health Centre. Following a few days debugging and training of the Health Centre maintenance person to operate and report on general performance of the machine, the machine was placed in continuous operation.

In November, AWI field engineers visited the site to replace a rotor blade that had been damaged when it fell from the machine due to a fault with a blade locating washer.

In 1987, HWC contracted with the Institute of Man and Resources, operator of the Atlantic Wind Test Site, to design, install and operate a micrologger system to provide continuous monitoring of the equipment. IMR was also requested to inspect the installation and to advise on electrical and mechanical safety of the equipment and installation.

In December, IMR's consulting engineer visited Hall Beach with a representative from EMR's Conservation and Renewable Energy Office (CREO) in Yellowknife. They met with the mechanical/electrical safety inspector for the government of the Northwest Territories to evaluate conformance of the installation to CSA electrical and wind energy safety codes. Following the meeting and inspection, the Safety Division of NWT ordered the equipment shut down until a few minor Canadian Electrical code infractions were rectified.

Summary of Utility Interconnection Arrangements:

The Health Center is supplied with power by the Northern Canada Power Commission (NCPC) from its 535 kW diesel generator plant in Hall Beach.

The Wind turbines are connected to the building's electrical distribution system on the customer side of the NCPC kWh billing meter. The meter is equipped with a detent or ratchet device to prevent reverse rotation of the meter during periods when the wind turbines supply power in excess of the building's demand. This prevents power delivered to the utility lines from being credited to the building service at the consumer rate.

NCPC will not realize any savings in their operations as a result of this project, and may actually experience a revenue loss. They were willing to approve

interconnection only under the condition that the installation would not adversely effect safety, quality of power, or reliability of their services.

The NCPC are of the opinion that customer owned generation from wind turbines will make it more difficult for them to supply electrical energy at the lowest cost and highest reliability. This opinion is based on the non-predictability of wind turbine power, equipment reliability, safety, revenue loss, and planning. When equipment reliability and performance is proven to be practical for operation in their remote systems, they will consider the addition of wind turbines as a component of their generation capacity.

Between October 3, and December 8, 1987 the installation was in service and produced 3792 kWh. This low output was caused by a mid-October to late-November shut down which occurred due to the failure of a blade locating washer.

PROJECT MANAGEMENT CONSIDERATIONS

Regulations, Codes, Policies

NCPC approved the equipment and project designs, including those for interconnection and quality of power. Health and Welfare Canada did not need an electrical inspection permit from NCPC (because the installation was on the H & W side of the meter). However, they did need an electrical permit from the government of the Northwest Territories Electrical Inspection Branch and failed to recognize this. As a result, the installation was shut down until the proper permit was obtained.

Organizational Considerations

In 1982, Health and Welfare Canada set up a steering committee to oversee the project. Unfortunately, membership on this committee kept changing, causing some problems with consistency on the project.

Cost Sharing and Financial Considerations

Project cost has been shared between Health and Welfare Canada, and Energy, Mines and Resources Canada. Problems were encountered with respect to fiscal year constraints, and new year allocations, because the project carried over several fiscal years.

Division of Responsibilities

The division of responsibilities was never made clear, and no overall organizational plan was clearly enunciated. As a result, the project was delayed several times because of permit problems, and the steering committee was not used as effectively as it might have been. When responsibility for nursing stations is turned over to the government of the Northwest Territories, this installation will become their property.

Recommended Power Option, and Limitations of Technology

Aerowatt International received the contract to supply, install, and maintain the installation. Civil work on site was done by Public Works Canada. The manufacturer provided a two year warranty, and during that time will provide

service from France. Health and Welfare Canada is the operator and provides normal maintenance through a local employee. There is some concern that the installation has not been located at a sufficient distance from the nursing station to avoid damage in the event of a structural failure in the installation.

ESTIMATED BENEFITS

Annual Energy Output	38,000 kWh
Utility Buy Back Rate	0$/kWh
Electrical Energy Cost	$0.55/kWh
Annual Savings	$21,000

APPENDIX G

LIST OF SMALL POWER PRODUCERS' ASSOCIATIONS

APPENDIX G: LIST OF SMALL POWER PRODUCERS' ASSOCIATIONS

Independent Power Producer's Society of Ontario
Box 1084, Station "F"
TORONTO, Ontario
M4Y 2T7
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APPENDIX H

GLOSSARY

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Avoided Cost:

The difference between the cost of producing power from an existing, conventional, diesel generator and the cost of producing power from a new, small-hydro or wind installation, taking into account the cost of amortizing the renewable energy development.

Blended Rate:

Combination of capacity and energy.

Capacity:

The overall generating capability of an installation.

Capacity Factor:

For a period of time is defined as the ratio between

1. The total kWh delivered in the period of time.
2. The product of the peak measured kilowatts delivered and the number of hours in the period of time.

Commissioning:

The final step in small power development: inspecting and testing the completed small power installation to ensure that it is complete according to contract documents, that there are no deficiencies, and that the system initially performs as intended.

Discounted Cash Flow:

Value in today's dollars of future income and expenses of a small power project which takes into account the fact that, due to inflation and the cost of money over time, future dollars are worth less in today's dollars.

Equity:

Difference between the value of the project and the outstanding loans for the project. If the difference is positive, equity is the debt free portion of a project. If the difference is negative, equity is the money directly invested by the owner.

Hydrological Data:

Statistics on the volume and speed of water in a river over time.

Internal Rate-of-Return:

The annual, compounded interest rate on the net cash flow from a small power project that would provide a net present value of zero.

H: Glossary

Land Tenure:

The means by which an individual, group or organization has authority to use the land (re: outright ownership, leasehold).

Letter of Credit:

Document provided by a financial institution to a small power producer assuring availability of funding to the limit stated.

Life Cycle Costing:

The full range of costs and benefits associated with a small power installation over the period of its useful life.

Mean Breakdown Time:

The average time between breakdowns of an electrical generating system.

Parallel Generation:

Privately generated power. Non utility generated power.

Payback:

The length of time for the net savings resulting from a capital investment to offset the capital cost of the investment.

Penetration of Grid:

Percentage corresponding to the maximum capacity produced by an independent system in relation to grid demand.

Performance Bond:

A form of insurance given by a contractor to an owner that the contractor will perform his agreed upon duties in an acceptable manner, failing which the insurer will arrange to complete work satisfactorily.

Purchase of Power Agreement:

An arrangement (contract) between a utility and a small power producer.

Rate of Return:

The ratio of annual cash flow to initial investment in a project, expressed as a percentage return on the initial investment.

Shared Savings:

A type of agreement between a utility and a small power producer to sell power based on some proportional split of the reduction in the cost of power as a result of using a small scale power system.

Small Power Producer:

An organization or individual (not utility) who operates a small scale power system (under 20 MW).

Small Scale Power Systems:

Systems that generate less than 20 MW of electricity.

Wheel Power:

The use by a small power producer of utility transmission lines to transmit electricity from the point of generation to the point of use.